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[OFFICIAL NOTICE.]

Third Annual Meeting, Texas Gas and Electric Light Association.

OFFICE OF THE SECRETARY, GONZALES, TEX., March 11, 1897.

The third annual meeting of the Texas Gas and Electric Light Association will be held in the Menger Hotel, San Antonio, Tex., on Monday, Tuesday and Wednesday, the 19th, 20th and 21st days of April, 1897. The following papers will be read:

"The Commercial Efficiency of the Incandescent Electric Light," by Mr. H. L. Monroe, Dallas, Tex.

"A Means of Largely Increasing the Summer Sendout of a Gas Works," by Mr. J. C. Lord, Fort Worth, Tex.

"The Storage Battery as an Adjunct to Small Electric Light Plants," by Mr. W. L. Hall, Mexia, Tex.

"A Few of the Many Details of Management," by Mr. A. E. Judge, Tyler, Tex.

"Little Things," by Mr. W. E. Holmes, Austin, Tex.

"Operating Expenses of Electric Light Plants," by Mr. J. D. Oliger, Cleburne, Tex.

"Electrolytic Deterioration of Water and Gas Mains," by Mr. W. A. Fraser, Dallas, Tex.

A few other short papers may be read. The Question Box will be a special feature of the meeting, and it is hoped the Wrinkle Department will also prove interesting.

It is expected, and an effort is being made, to have an exhibit of gas and electrical appliances, which it is believed will be both interesting and instructive.

The last day of the meeting is "San Jacinto Day," a great holiday in Texas, and in San Antonio especially, when the "Battle of the Flowers" takes place.

Effort is being made to obtain cheap railroad rates, and everything will be done to make the expense of attending as light as possible.

The Secretary will take pleasure in sending blank applications for membership and information regarding the Association to those interested.

F. R. STARR, JR., Secretary.

[OFFICIAL NOTICE.]

April Meeting, Society of Gas Lighting.

OFFICE OF THE SECRETARY, April 1, 1897.

The April meeting of the Society of Gas Lighting will be held in the Arena, No. 39 West 31st street, New York city, at 3 P.M., of Thursday, the 8th inst.

FRED. S. BENSON, Secretary.

[OFFICIAL NOTICE.]

April Meeting, Guild of Gas Managers.

OFFICE OF THE SECRETARY, April 1, 1897.

The April meeting of the Guild of Gas Managers will be held in Young's Hotel, Boston, Mass., at noon of Saturday, the 10th inst.

A. K. QUINN, Secretary.

BRIEFLY TOLD.

DEATH OF MR. ADOLPH VOGL.—We regret to have to report the death of Mr. Adolph Vogl, who succumbed to an attack of paralysis, on the morning of March 24th, at his home, No. 16 Martin street, Cambridge, Mass. The suddenness of his demise will be appreciated when it is stated that he was stricken, on the afternoon of March 19th, while transacting some business in the offices of the Charles River National Bank. Deceased was born in Bohemia, December 9th, 1826, but had lived in Cambridge for many years, where his capacity as an expert accountant had wide recognition. Deceased acted as Treasurer of the Cambridge Gas Light Company, we think since the death of Mr. Estes Howe, and his record there is that of a competent, trustworthy and respected officer. He was a persistent student despite his advanced years,

the study of languages, of which he mastered several, being his main source of recreation. He was a disingenuous man, using that word in its best sense, and his genial, unaffected ways of life made for and retained to him friends without number. He is survived by a widow, a son and two daughters.

THE PASSING OF MR. BURDETT LOOMIS.—The Committee on Incorporations of the Connecticut Legislature has been listening to testimony for and against the granting of a charter for the Capitol City Gas Company, to Mr. Burdett Loomis and his associates, who propose to supply fuel gas in the city of Hartford and the outlying districts. Quite an array of eminent counsel have been engaged in assisting Mr. Loomis, and the same versatile gentleman has called to his aid experts of one kind or another, the lawyers and the experts, of course, acting jointly on behalf of their retainer, to show that legally and financially the Capitol Company is all right. They have done their best, but as their cause was a poor one, they do not seem to have made much progress; which lack of advance of course is traceable to their poor cause rather than to their paucity of ability. On the other hand, the Hartford City Company also had lawyers and experts, and as their cause was a good one, their success (for at this writing we think it is quite safe to say that Mr. Loomis' Company will not receive a charter this year) points well the support that a good cause gives to ability. Just now, what with the rebuff that Mr. Loomis and his associates came to at the hands of the Cleveland (Ohio) city fathers (Mr. Loomis would just as soon get franchises for cities or places widely separated as he would for places not far apart), his decidedly unprofitable actual operations in the fuel gas line at Bridgeport, Conn., and the outlook for a failure in Hartford, it would seem fair to assume that Mr. Loomis and his associates are passing out of the field of their hopes. *Suum cuique.*

AMMONIA FROM SPENT OXIDE.—At the last meeting of the New England Association of Gas Engineers a paper was presented by Mr. Carl H. Graf, of Lawrence, Mass., on the "Extraction of Ammonia from Spent Oxide."[1]

Although the theme is not entirely a new one, it attracted sufficient attention to lead us to believe that many minds would be turned to the development of the method outlined, and notwithstanding the fact that we do not wish to decry the merits of the system involved, or deter those so inclined from entering more fully upon its practice, we feel called upon to present certain relative features that will tend to show where the recovery of ammonia compounds can be more satisfactorily and economically carried on than by the process described, in addition to increasing the value of the oxide as a purifying agent for the removal of those impurities to which it is better suited, and for which it is most generally employed.

In computing the efficiency of oxide as a purifying agent, it is presupposed that the gas, upon entering the inlet of the first purifier, is in such state that none other than sulphureted hydrogen and other sulphur compounds, aside from those of the cyanogen group, are to be acted upon. Hence we are compelled to say that, as a source of revenue, the use of the oxide as a means of removing ammonia, to the detriment of its efficiency in other directions, is not only a doubtful economy, but a positive drawback to the result that all gas men are after—the greatest revenue obtainable from the residual bye product source to offset the first cost of the raw material. Even though admitting that a plant is so handicapped in its scrubbing and condensing capacity that the purifiers have to be called upon to perform the work that should properly devolve upon the scrubbers and condensers, the income derived from working the spent oxide for its ammonia compounds yields so small a margin that by far the more profitable investment would be in the direction of an efficient scrubber, the product from which would yield a certain and continuous revenue, besides affording an additional economy in the subsequent manipulation of the remaining gases, and admitting of a more extended efficiency of the oxide itself. In the more advanced systems of oxide purification, it has been demonstrated that the life of the mass is almost wholly dependent upon the physical condition of the gas it is called upon to purify.

Practice has shown that the revivification of the material, *in situ*, after its introduction into the boxes, is quickly and satisfactorily effected when the cover of the box is removed and atmospheric air drawn through the mass by means of a steam siphon arrangement attached to the bottom of the box. Of course the success of this practice and the number of times it may be performed are greatly dependent upon the condition of the material; should the ammonia compounds be so prevalent as to make their final recovery from the oxide desirable, from a money point of view, the practice would be so restricted as to make the expense of purification much in excess of what it should be had these compounds been taken care of in proper apparatus previous to the purifier inlet.

1. See JOURNAL, *ante*, p. 335.

NOTES.—The plants of the Mount Sterling (Ky.) Gas Light Company, which included an electric lighting annex, were sold at foreclosure, March 27th. The purchaser was Mr. George W. Harper, of Cedarville, Ohio.——The proprietors of the Hagerstown (Md.) Light and Heat Company have determined to reduce the rate on gas used for fuel to $1.25 per 1,000 cubic feet.

[Communicated Article.]

Calorimetry and Heat Unit Values of Gases.

By MR. FRED. B. WHEELER, Long Branch, N. J.

The interesting paper,[1] by Mr. C. D. Jenkins, Inspector of Gas and Gas Meters for Massachusetts, read February 18, at the Twenty seventh Annual Meeting of the New England Association of Gas Engineers, has attracted my attention; also the remarks and figures quoted by Mr. Charles H. Nettleton in discussing it. Mr. Nettleton's remarks probably voiced the thoughts of many, and determined me to investigate these figures theoretically.

Any unit volume of illuminating gas is composed of certain percentage of volumes of the elementary and hydrocarbon component gases. If these volume percentages be multiplied by the number of heat units evolved upon complete combustion of the particular component gas in question, we shall have, in summing them, the total number of heat units evolved upon complete combustion of the complex illuminating gas, due attention being paid to the proper units of volume, temperature and pressure. It is well to add that these constant multipliers have been determined with marvelous skill and patience by Thomson for each component gas known: The details of his work can be found in his *Thermochemie Untersuchungen.* They stand absolutely unchallenged. They are given in calories per kilo, which have to be reduced to English units. These English multipliers are as follows:

TABLE I.

CO.....	348 B.T.U. per cubic foot at 32° F., and 29.92 inches B.
H.....	349
CH_4.....	1,065
C_2H_4.....	1,673 Illuminants proper, exclusive of benzene, usually
C_3H_6.....	2,509 figured in equal volumes, with 2,000 as multiplier.
C_6H_6.....	4,010

I submit below Mr. Jenkins' table, with his result of 681.8 units, at 60° and 30 inches, by Junker calorimeter; also Table II., giving results in heat units theoretically.

I also submit the analysis of carbureted water gas exhibited by the United Gas Improvement Company, at the recent gas exposition, shown probably as an ideal (?).

With this, in Table III., is the calculated value deduced as above. It was this analysis that was quoted by Mr. Nettleton, probably, as his figures are identical.

I next submit a sample of Long Branch gas, made March 23d, with Table IV., and a sample analysis from Dr. Stillman, with Table V. The result of Table V. is 662 B.T.U. Now the heating value of this gas, by Junker calorimeter, was 668 B.T.U., a difference from the theoretical result of 5.1 B.T.U., or only .77 of 1 per cent. excess.

It was found in a large number of Junker calorimeter tests, at the Stevens Institute, that the experimental determination of heat units did not vary more than 1 per cent. of the theoretical value, including the latent heat of the products of combustion; and, even neglecting the heat carried away by the waste products, the variation was no more than 2 or 3 per cent.

TABLE II.—*Analysis Boston Gas*, by Mr. C. D. Jenkins. Candle power, 25.7; spec. grav., .673; at 32° F. and 29.92 ins. bar.

Illuminants....	15.55	.1555 × 2,000 =	311.00
CH_4.....	21.44	.2144 × 1,065 =	228.33
H.....	30.29	.3029 × 348 =	105.40
CO	26 90	.2690 × 349 =	93.88
N	3.06	.....	....
O.....	....	.....	....
CO_2.....	2.76	.....	....
			738.61 B.T.U.

Net B.T.U., 60° F., 30 ins. bar., 681.8.

1. See JOURNAL, *ante*, p. 442.

TABLE III.—*Analysis United Gas Improvement Company's Gas*—Figures shown at Gas Exposition. Candle power, 25.3; spec. grav., .665; 32° F., 29.92 ins. bar.

Illuminants	14.4	.144 × 2,000 =	288.00
CH_4	16.8	.168 × 1,065 =	178.92
H	32.7	.327 × 348 =	113.79
CO	30.2	.302 × 349 =	105.29
N	3.1		....
O	.4		....
CO_2	2.4		....
			686.10 B.T.U.

Heat units, 766.11

TABLE IV.—*Long Branch Gas.* Candle Power, 24.45; spec. grav., .682; 32° F. and 29.92 ins. bar.

Benzene vapors	1.4	.014 × 4,010 =	56.14
Illuminants $\{C_2H_4 \atop C_2H_2\}$	13.6	.136 × 2,000 =	272.00
CH_4	19.1	.191 × 1,065 =	203.41
H	31.3	.313 × 348 =	108.92
CO	27.4	.274 × 349 =	95.62
N	3.8		....
O	.4		....
CO_2	3.0		....
			736.09 B.T.U.

TABLE V.—Analysis by Dr. Stillman. 32° F. and 29.92 ins. bar.

Illuminants	12.80	.1280 × 2,000 =	256.00
CH_4	17.83	.1783 × 1,065 =	189.59
H	37.95	.3795 × 348 =	132.06
CO	24.20	.2420 × 349 =	84.45
N	5.02		....
O	....		....
CO_2	2.20		....
			662.10 B.T.U.

Numerous tests with a Hartley calorimeter upon New York city gas give 760.5 B.T.U. per cubic foot.

It is absolutely safe to say that the analysis must show on its face the component percentage volumes necessary to give, when multiplied by the proper numbers, the heat units claimed. For instance, when a gas analysis shows the composition of Table VI., the analysis having been carefully made, we know the calorimeter will show close to this theoretical result. We know it is a 28 candle power gas, at least, and being made right in New York.

TABLE VI.

At 32° F., and 29.92 inches barometer:

Benzene, etc.	.015	× 4,010 =	60.15
Illuminants	.1529	× 2,000 =	305.80
CH_4	.1985	× 1,065 =	211.40
H	.3205	× 348 =	111.53
CO	.2740	× 349 =	95.62
			784.50 B.T.U.

If the benzene vapors are separated from the rest of the illuminants, as in the Long Branch and New York city samples, quite an addition is made to the apparent calorific power, and this is borne out by calorimeter tests. In 24 and 25-candle power gas it is usual to find 1.5 per cent. of the benzenes. In Mr. Jenkins' sample this would add 30 B.T.U. to result in table, making 768.61, which exceeds the United Gas Improvement Company's sample of 766.11. If there were 1.5 per cent. of benzene in the latter, 30 B.T.U. will be added to Table III, making 716.1 theoretically possible. If the illuminants in Table III. be considered as made up of—

1.5	per cent.	benzene, C_6H_6,
2.0	"	ethylene, C_2H_4,
10.9	"	propylene, etc., C_3H_3,
14.4		

we have the result in Table III. increased to 765.11 units, or actually only 1 unit less than their claim. In Jersey City and Long Island City gas, tested by Stevens Institute, the values found were 754.2 and 783.8, respectively.

To reduce heat units from dry gas, at 32° F. and 29.92 ins. bar., to gas saturated with moisture, at 60° F. and 30 ins. bar., multiply by the constant 0.9298. This reduces the heat units to the basis of condensation at 60°, and gives a result, for Mr. Jenkins' gas, of 686.8, closely agreeing with his figures. This result is between the values of Table II. and his value—all of Mr. Jenkins' values are for B.T.U. saturated at 60° and 30 ins. bar. If his sample of Newton gas be figured with the same constants as above, we find the values:

670.23 for dry gas, 32° F. and 29.92 ins. bar.
623.55 for saturated gas, 60° F. and 30. ins. bar.

which differ widely from his values.

From this discussion it will be seen that the number of heat units in a gas correspond practically with the theory, and that different people get different results, depending on the base of reference and on the accuracy of the constant multipliers used; but if the above multipliers be used, the theoretical values will be very close to the best calorimetric work.

[Translated and adapted for the JOURNAL, from the *Journal fur Gasbeleuchtung*, by Mr. F. Egner.]

Some Naphthaline Experiences.

At a meeting of one of the German Associations of Gas Engineers, Mr. H. Hoffman, of Kaiserlautern, presented a paper in which the author reported that, notwithstanding their practice at his works was in line with condensation regularly and carefully conducted, naphthaline stoppages had been of frequent occurrence. It was finally determined to attempt to overcome the evil by graduated cooling of the gas, and accordingly a large atmospheric condenser was to be added to the plant. During the preliminary work to this end quite by accident the cause of the naphthaline troubles was discovered, and traced to the following unexpected source.

Like all gas works, the plant had steam boilers and pipe connections to the gas apparatus, enabling the ready clearing out of obstructions of an ordinary nature. While overhauling the pipes, a valve, which had not been suspected, was found to be leaky to the point of permitting the passage of steam into the gas mains, directly after the last cooler in the series used. That this cause was not discovered earlier was due to the fact that, supposing the trouble to have originated from the coal used, attention from the real source was entirely diverted. As a matter of course, all steam connections with the gas mains were disconnected without delay, but in such a manner that the connections could be restored in a few minutes' time whenever necessary.

Mr. Hoffman relates interesting experiences, which no doubt confirm similar ones had by readers of the JOURNAL, as they did those of such well-known European gas scientists as Dr. Bunte and Messrs. Kunath and Hesse. For instance:

In the hottest season of a previous year, a service pipe, through which gas was brought to a cooking range, had to be cleared twice a day from naphthaline. This pipe passed through a very cool cellar, and an entire cure was effected by casing the pipe with a non conducting covering.

In another case a 4-inch gas main had to be conducted from one to the other side of a 20-inch water main. This was accomplished by dropping the gas main down on one side, rising on the other side of the water main. Upon a break in the gas pipe at that point it was found to be completely stopped with naphthaline. After repairs had been made the pipe was covered with a suitable pipe covering, and there was no more trouble with naphthaline at that point, although elsewhere in the system stoppages continued to be as frequent as ever.

After the new and efficient cooling apparatus had been in operation for some time, Mr. Hoffman was curious to know if naphthaline was still contained in the gas, so he connected a small steam pipe to the outlet main, and allowed a *very small* quantity of steam to blow continuously into it for two days. He said most emphatically that he should advise no one to repeat that experiment. The first day after the admission of the steam complaints of stoppages commenced to come in, and these troubles not only increased to volume theretofore unknown, but the undesirable effects continued to be felt for some time.

Mr. Hoffman stated that he could not explain the matter in any other way than that the naphthaline was separated from the gas by the action of the steam, and carried on by the gas current, from point to point, during differences of temperature, until it was eventually carried to the farthest points of their main system. At any rate, he concludes that finished gas must be considered to always contain small quantities of naphthaline, and that the evils of naphthaline stoppages can only be effectively reduced to a minimum by efficient, carefully graduated condensation, and subsequent suitable design and proper laying of main and service pipes.

Gaseous Fuel as a Means of Cheapening Electricity.

By Mr. Nelson W. Perry, E.M.

In these days of extending areas to be reached by electric light and power companies the management is constantly being put into a quandary as to how they are to be reached. In electric lighting enterprises employing the direct current the areas that can economically be reached are already pretty well covered, and these are the best paying areas. Just beyond there is new business to be had if it only could be supplied, but to supply it would involve additional outlays far out of proportion to the reasonable expectation of immediate returns. The management therefore feel that they must, for the present at least, forego the immediate increase from these outlying districts, and must depend for new business upon the natural or stimulated growth of custom within the districts already partly supplied.

Where the alternating current is employed, very largely increased areas are so easily made tributary to the central station that the temptation to supply scattered customers has been in most cases too strong to be resisted, and I believe if reliable statistics could be compiled they would show that alternating current lighting stations have proved far less profitable as a class than have those using the direct current. The very limitations which have prevented the direct current entering the field to which the alternating current is best adapted have proved its greatest safeguard.

A comparative study of a very large number of load lines of direct and alternating current lighting stations discloses a peculiar state of affairs, viz., that as a rule the alternating current load lines have almost uniformly a squarer and broader topped peak than have the direct current stations and a generally better load line. This is largely due in some cases to the fact that in the scattered service of the alternating current a very much larger proportion of the total output is employed for street lighting, but it is also partly due to the undoubted fact of the larger proportionate losses at light loads, due to transformer and other losses peculiar to the alternating current, which makes the mean load higher than it should be. This feature is particularly observable in the curves of an alternating current station, of which I have diagrams for nearly every day in the year, which supplies such a small proportion of its total output to street lights as to render the effect of these practically negligible.

With the direct current system the introduction of high voltage lamps, which have already demonstrated their feasibility abroad and to a less extent in this country, will be a partial solution of the question of supplying greater areas, if it does not lead to the same temptation which has beguiled the alternating current manufacturers, for of this there is constant danger.

In electric railways, in which distances rather than areas are involved, the question is far more serious, for in this latter case the cost of distribution increases almost strictly as the square of the distance, whereas in electric lighting the cost approaches more closely to a direct proportion to the distance.

This comparison becomes more strictly true when we consider the suburban extensions of our electric roads, which in fact are now becoming about the only extensions open to our street railway managements, and the unfavorable character of the comparison puts the street railway problem in a still more unfavorable light when we consider that in the outlying districts the immediate traffic to be gained by the largely increased outlay is disproportionately small to that outlay and of a far more irregular character.

In order to make such new lines profitable at all, it has become quite popular to stimulate traffic by inaugurating pleasure resorts and providing amusements at the further end of the line. The wisdom of this is questionable, for to provide for this induced traffic provision must be made both in the way of increased plant and in additional copper largely in excess of the natural demand. This increased provision is at best utilized but a small portion of the time, and the earning capacity of the investment as a whole is greatly decreased.

Returning to the electric lighting industry, it is at best on an unsatisfactory basis, and something must be done to better it. In the most desirable locations, which are in our largest trade centers, such as Chicago, New York and Boston, where probably of all places in the world the electric lights are most dense, and therefore where they can be supplied at least cost for distribution, what do we find? We find those companies whose stocks are selling above par and which are paying dividends regularly, making new issues of stocks and bonds or applying for permission to do so in order "to raise funds for extensions."

Take the New York Edison Electric Illuminating Company as an example, whose stations are perhaps as favorably located as any to be found, and whose stock is selling above par. It has a capital stock of $10,000,000, of which $7,988,000 have been issued, and of bonds, $7,118,000, of which $6,430,000 have been issued, making a total authorized capital liability of $17,118,000, of which $14,368,000 have been issued.

According to its report for 1895, its total maximum capacity was 75,000 amperes, or the equivalent of 150,000 16-candle power lamps. According to Mr. John W. Lieb (Transactions Am. Inst. Electrical Engineers, 1895, p. 56), the load factor of the combined Edison stations on the day of the greatest output in 1894 (December 10) was 34½ per cent.

To compare the capital outlay for electrical service with that required for equivalent gas service is exceedingly difficult; first, on account of the paucity and unreliability of gas statistics, and second, because of the well known enormous over-capitalization of gas enterprises in New York, partly due to the watering of stocks and partly to the duplication of plants that would have been totally unnecessary had the gas industry grown legitimately under a single head instead of being the outgrowth of repeated consolidations of competitors in the same territory. But taking these statistics as we find them, the total authorized capital of the various gas companies, including stock and bonds, is given as $58,109,000, and their annual output, as near as I can get it (average of two estimates by different gas authorities), 14 billion cubic feet. This gives a mean output per hour of 1,600,000 cubic feet. Counting 5 cubic feet per hour as the equivalent of a 16-candle power incandescent lamp, this means an average supply of 320,000 lamps, and if the load factor be assumed the same as given for the Edison stations, it means a maximum supply for something more than 927,000 burners. This is in round numbers 6.2 times as many lights as the Edison Company on a total authorized capitalization of $17,118,000 is able to supply. On this basis the capitalization necessary to supply the same number of lights as the gas companies can now furnish would be $106,000,000, as against $58,000,000 for the gas companies. For many reasons, some of which have been specified, the comparison is manifestly unfair to gas, and it seems not at all improbable that gas service can be supplied on a capitalization of not to exceed one-fourth (instead of one-half as shown above) that required for equivalent electric service.

There is certainly something wrong in this state of affairs which the electrical engineer must correct. The most significant feature of the situation is that notwithstanding the fact that gas is distributed over very much greater distances than low tension currents are, the consumer can buy it so cheaply that he can produce electric light more cheaply by burning it in a gas engine, even after incurring the losses in conversion in the engine and dynamo, than he can buy it from the electric company. If this be true in large cities like Chicago, New York, Philadelphia, Brooklyn and Boston, and it cannot be gainsaid, what must be the condition of light and power plants in smaller and less favorably situated cities?

Some, by rigid economy and the best management, are making a little money; more are running on a very close margin, and still more are undoubtedly eking out a precarious existence, while their machinery is wearing out, and making no provision for its replacement when it requires renewal; and all are charging more for their lighting than gas can be and is provided for where gas is furnished at all. It is very clear if the electric light could be supplied at a small profit at the same price as gas it would furnish an enormous increment to the electric light manufacturer's income. The advantages of electricity as a useful agent in the household over gas are so apparent that there could no longer be any competition between the two. It would result in larger profits for those companies now making money, and place most of those now operating at a loss upon a dividend-paying basis.

Our electric railways, except in exceptionally favored situations, as in our larger cities, are in no better condition than the lighting companies, if in fact they are in as good condition.

Our electrical engineers have bent every effort to ameliorate matters, and the best of our electrical stations are now models of mechanical and electrical engineering skill. Boilers of the highest efficiency, engines of the greatest economy and all the accessories have been brought to a state of perfection which leaves little expectation for improvement in those directions. Greater distances have been brought under the service of existing stations by means of the booster and of subsidiary outlying storage battery centers of supply, and the load line has been levelled off by the storage battery plants at the station itself, and yet the most optimistic will not maintain that finality has been reached or that the desired end has as yet been accomplished. Electricity can be produced at the station by large compound condensing engines more cheaply than can gas light at the gas works.

If we assume that illuminating gas costs but 20 cents per 1,000 cubic feet to manufacture and that 5 cubic feet per hour are consumed to produce 16 candle power, the cost per light per hour at the gas works would be $\frac{1}{100}$ of a cent. If, on the other hand, we assume that an electrical horse power hour can be produced at the central station for 1 cent and that thirteen 55 watt lamps can be supplied thereby, they would cost $\frac{1}{13}$ of a cent per hour.

When we still further consider that recent tests in England have shown that a brake horse power can be produced under test conditions in a gas engine on 14 cubic feet of ordinary town gas (16 candle power) and that such gas costs delivered in our large cities only about $1.50 per 1,000 cubic feet, it becomes evident that we can pay the gas company its profit on manufacture, distribution and collecting and still produce electric light in our central station at a less cost than gas light, and yet when we have distributed our energy to our customers we must charge them more than the gas company does, light for light, and then be satisfied with far less profit on an increased investment than the gas company gets on its lesser investment. It seems to me that this indicates something radically wrong and in a direction to which our engineers have given little attention, viz., in our methods of distribution.

We have constantly striven to increase our radii of distribution and have done this until we could go no further and give satisfactory service. We have then built additional stations, and many managers now find themselves again confronted with the same question—is it possible for me to increase my radius, or must I decide between foregoing the increased business just beyond my reach or, taking the bull by the horns, build another station?

Unquestionably the gas engineer has the advantage of the electrical engineer in his method of distribution, but he has this advantage solely through the apathy of the electrical engineer and not through any inherent right. The facts are indeed the other way, for the pressure at which the gas engineer may distribute his gas is limited to that at which gas can be burned at its most efficient rate. No such limitation is placed upon the engineer who distributes gas for fuel purpose. Compressed air is being daily delivered through twenty miles of pipes with a pressure at the point of delivery of approximately 100 pounds to the square inch and a leakage loss not to exceed 10 per cent., and gas for fuel purposes can be delivered through the same pipes at the same pressure and leakage, whereas for illuminating purposes the final pressure is limited to a fraction of a pound in pressure to the square inch, but even under these conditions the Consolidated Gas Light Company of New York in distributing gas from the Harlem River clear down to the Battery, a distance of 13 miles, and the Gas Light and Coke Company of London is delivering gas over 70 miles of territory through 2,000 miles of mains to a distance of 17 miles from its station. On the same investment in pipes, therefore, a far greater gas delivery can be made for power purposes than can be made for lighting purposes, and the electrical engineer who will deliver his energy to the centers of distribution in the gaseous form will have an enormous advantage over the gas company by reason of his ability to distribute his gas at greater pressure.

But he must be careful not to throw away the advantage thus gained by distributing his electrical energy over too extended areas. It is my conviction that the tendency to increase the radius of distribution is in the wrong direction and that our solution is in the contrary direction, viz., in increasing the number of our centers and decreasing the radii.

As regards the economy of distribution of energy in the gaseous form I gave some figures in another place[1] which I wish permission to quote here.

I assumed that we wished to transmit our gas to a distance of 5,000 yards or nearly three miles through a 12-inch pipe; that this gas has a specific gravity of 0.55 as compared with air, and that its calorific power was such that when burned in a gas engine under fair conditions it would require 25 cubic feet to produce one brake horse power hour. In order to allow for bends, I assumed that there were twenty-five 90° bends, an average of one every 200 yards. The results obtained under our varying initial pressures were as follows:

Inches Water Pressure.	Cubic Feet Delivered.	Increase of Pressure Required for Each 90°-Bend.	Total Increase of Pressure for 25 90°-Bends.	Total Initial Pressure in Inches Required to Deliver Gas.	Horse Power Delivered, 25 Cubic Feet 1 H.P. Hour.	Foot Pounds per Second Consumed in Transmission.	Velocity of Flow in Feet per Second.	Per Cent. of Power Transmitted Consumed in Transmission.
1 inch.	12,500	.0016 inch.	.04 inch.	1.04 inch.	500	17.3	4 feet	0.007
2 inches.	18,500	.0034 "	.085 "	2.015 "	700	51.5	6 "	0.013
3 "	23,000	.006 "	.1495 "	3.15 "	920	105.12	8 "	0.0208
4 "	25,500	.0076 "	.189 "	4.189 "	1,020	151.5	8.8 "	0.027
5 "	28,000	.0086 "	.215 "	5.215 "	1,120	204.7	9.6 "	0.033
6 "	32,000	.0113 "	.28 "	6.28 "	1,280	284.0	11 "	0.04
7 "	34,000	.0135 "	.34 "	7.34 "	1,360	359.0	12 "	0.018
8 "	36,000	.0147 "	.39 "	8.39 "	1,440	430.0	12.5 "	0.054
9 "	38,500	.0158 "	.4 "	9.4 "	1,540	501.0	13 "	0.06
10 "	40,000	.0183 "	.46 "	10.46 "	1,600	602.0	14 "	0.07

This shows that by this means 16-horse power can be delivered under 10 inches of water pressure through a 12-inch pipe with 25 90°-bends at a distance of 5,000 yards with an expenditure of but 1.12-horse power, or $\frac{1}{100}$ of 1 per cent. of the power delivered.

The Gas Light and Coke Company, of London, in its straightaway transmission of 17 miles, which is comparable with some of our longest electrical transmissions, uses 30 inches initial pressure. With this pressure we could deliver through the 5,000 yards of 12-inch pipe approximately 2,700-horse power, with an expenditure of about $\frac{1}{100}$ of 1 per cent. of the power delivered.

The cost of this pipe, which would weigh 800 tons, would be at present prices $16,000. If we should endeavor to deliver 2,700 horse power electrically to the same distance with the same efficiency of transmission at 10,000 volts, it would require copper equivalent to 47 0000 B. & S. wires, which would weigh 900,000 pounds and cost, at 12 cents per pound, $108,000, or 6½ times as much as the gas mains, and require transforming down after it was delivered before it could be utilized.

The above estimates allow nothing for leakage, which in gas mains is sometimes, though not necessarily, very large. According to Mr. James McGilchrist, the losses in leakage on the 2,000 miles of mains of the London Gas Light and Coke Company, through which a maximum of 128,000,000 cubic feet per day is delivered, is only a fraction over 5 per cent.

The extreme cheapness of transmission of gas distribution enables the gas manufacturer to locate his generating plant where real estate, coal and water are cheap, and thus we find all of the gas plants in New York city located on the water front, whereas the principal electric light plants are placed on the most expensive land at such a distance from the water front that the hauling of coal and the disposal of the ashes costs one of the most favorably located of these plants 54 cents per ton on an aggregate of some 50,000 tons of coal per annum. Water for condensing or other purposes costs the largest consumers in New York 10 cents per 100 cubic feet, rendering it in most cases more economical to operate engines non-condensing than to run them condensing.

These facts, and the further fact that the gas manufacturer utilizes the majority of his generating plant continuously and at its maximum efficiency, explain why on an investment of less than one-third he can accomplish essentially the same results more cheaply than can the electrical engineer.

The gas engineer, by reason of the facility of storage of his product, has practically no standby losses, and his total investment is constantly worked to nearly its maximum capacity. About the only part of the plant not so continuously employed is his distributing mains, for these are not employed to their fullest capacity except for an hour or two each day. He has avoided these inefficiencies over a portion of his system, however, by establishing distributing gasholders at convenient centers, so that the mains connecting these distributing tanks and the generating plant are continually employed, and only those radiating from these centers fall short of their full earning capacity.

The electrical engineer has appreciated the effect of the variable character of his load upon the earning capacity of his plant, and some of the most progressive engineers are convinced that it is economical to supplant the extra engines and dynamos necessary to take the peak of the load with storage batteries which cost as much as, if not more

1. "Gas vs. Electricity for Power Transmission," *The Engineering Magazine*, October and November, 1896.

than, the apparatus displaced. But his transmission and distribution lines, which cost more than those of the gas plant, as we have seen, are still utilized to their full extent but a small portion of the time. To ob viate this the booster system with outlying storage battery centers of distribution has been suggested and in some cases employed, and this, it seems to me, is a step in the right direction. But we must go further. We must first of al! materially reduce our enormous fixed charges, and next we must find some means of reducing our operating expenses, and accomplish both of these reforms without sacrifice of reliability of service.

Can we do better than to take a lesson from the gas engineer who has already solved in a measure these problems? I not only think we can profitably copy after him, but that we can possibly go him one better.

The first step would be to move our generating plants from the expensive sites now occupied and place them on cheaper land where fuel and water may be had most cheaply. If by this move we can save in our boal bill 54 cents on every ton of coal costing, say, $2.50, we have at once made a material gain in operating expenses as well. If by adopting gaseous transmission we can cover a vastly increased area at the same cost, we have made another gain, and if by converting our coal into gas we are enabled to utilize coal that cost $1 or $1.50 per ton, whereas before we were paying $2.50, another material gain has been accomplished.

If by reason of the exceedingly cheap method of gas storage, which, when employed on a large scale, can be provided on an investment of but $1.50 per horse power hour capacity[1] we can employ the real estate occupied, the buildings, apparatus, labor and administrative force to their fullest capacity, we have again reduced very materially both our fixed charges and our operating expenses.

We have seen that one gas company in London is supplying 70 square miles of territory through 2,000 miles of pipe with a leakage loss of but a fraction over 5 per cent., and that it has a straightaway transmission of 17 miles. The economical distribution of gas over areas much larger and to distances much greater than ever have been attempted electrically by the direct current is therefore no longer an experiment, but an accomplished fact, and this fact becomes still more impressive when we realize that after paying all the expenses of such transmission and the gas company's profit, we can buy that gas and produce more light from it through the intermediary of the gas engine and dynamo at less expense than we can buy electric light or than we could get from the same amount of gas burned in the ordinary way.

If these be facts, they are very impressive and should stimulate us to see how far we as purveyors of electric power and light can avail ourselves of them.

My own suggestion expressed on several previous occasions is this:

Locate a gas generating plant with regard to economy of land, fuel, etc., and install at this point a large gasholder, so that every dollar of investment at that point would have a maximum earning capacity. Taking advantage of the greater economy of gas over electrical transmission, transmit this gas to local centers of distribution. At these points smaller gasholder should be erected so as to enable the gas mains to be used to their maximum capacity. Gas engines would take the place of steam boilers and engines, less space would be required and standby losses entirely avoided. If our load line were such as to warrant the introduction of storage batteries, these would supplant the local gas storage and the real estate at this point, and dynamos, engines and labor would all be employed continuously to their best advantage. In fact every dollar of investment from the gas generating plant to the electrical plant at the local distributing center, including the gas mains, would be employed to its best advantage, leaving only the electrical distributing mains to be employed under a low load factor.

The economies in investment and in operating expenses thus accomplished would enable us to reduce the radii of distribution, and thus to give the same service with less investment of copper, or better service with the same investment, and to reach unsupplied territory at a profit not now accessible nor profitable by present methods.

I do not know just what proportion of the total cost of illuminating gas is due to the refinements of manufacture rendered necessary for the service it supplies, but it is undoubtedly large. Gas sufficiently clean for fuel purposes without its high illuminating properties, but of nearly equal calorific power, could doubtless be manufactured for consider ably less than it costs the illuminating gas companies. The fact, too, that it could be distributed at very much higher pressures would make still further for economy.

As to the quality of the gas, it will pay to generate such as has a high calorific power if it is to be transmitted far. If to be generated locally and used on the spot, a low grade gas such as the Dowson gas, having a calorific power of about one-fourth that of ordinary 16-candle power gas, would undoubtedly be the most economical, but by reason of the greater volume required and of the greater frictional losses due to its greater specific gravity, such a gas would be less economical where long transmissions were involved than the richer and lighter gas produced at somewhat higher first cost.

1. A 500-foot holder would cost, erected in New York, about $700; a 1,000-foot holder, $900 to $1,000; a 150,000-foot holder, $15,000, and a 3,000,000-foot holder, $180,000. Assuming that a gas engine requires 25 cubic feet per horse power hour, which is exceedingly liberal for the best types of modern gas engines using gas of the average quality of our ordinary illuminating gas, the investment per horse power hour capacity for the largest sized tank named would be as given.

Facts and Figures from the Annual Report of the Massachusetts Gas Inspector.

The following is extracted from the annual report of the Inspector of Gas Meters and of Illuminating Gas (Mr. C. D. Jenkins) for the State of Massachusetts:

During the year ending December 31, 1896, 22,875 gas meters were tested, 588 gas inspections made, four meter provers graduated and a number of eudiometric gas analyses made.

Of the total number of meters tested 21,675 were either new or repaired and were presented for inspection by the manufacturers or gas companies. A few of these meters failing to register correctly were returned for adjustment and then re-tested.

The remaining 1,200 belong to the class of "Complaints"; these are meters which, being in use, are suspected by the consumer or gas company of registering inaccurately; section 12 of Chapter 61 Public Statutes provides, in such case, for the official re-inspection of the meter on complaint of either party. Of these, one would not pass gas, seven would not register, 602 were correct within the legal limits of 2 per cent. fast or slow, 477 were fast, the average error being 4.87 per cent., and 113 were slow, the average error being 8.41 per cent. The total average error of the 1,192 registering meters was 1.22 per cent. fast. Of the fast meters 278 were less than 5 per cent. fast, 167 between 5 and 10 per cent., 24 between 10 and 15 per cent., 6 between 15 and 20 per cent., one 20 and one 22 per cent. fast. Of the slow meters 40 were less than 5 per cent. slow, 44 between 5 and 10 per cent., 14 between 10 and 15 per cent., 5 between 15 and 20 per cent., one 23, one 24, two 25 and one each 27, 35, 42 and 80 per cent. slow. A comparison with previous years of this same class of meters is given in the following table:

	Fast Meters.		Slow Meters.			Total.	
Year.	Number.	Per Cent.	Number.	Per Cent.	Correct Meters.	Number.	Per Cent.
1890..	64	5.32	20	23.60	134	218	0.60 slow.
1891..	52	4.74	34	10.03	144	230	0.41 slow.
1892..	105	5.67	49	9.28	190	344	0.41 fast.
1893..	197	5.10	46	9.30	284	527	1.23 fast.
1894..	217	4.70	55	8.56	327	604	0.99 fast.
1895..	301	4.73	93	9.72	549	957	0.40 fast.
1896..	477	4.87	113	8.41	602	1,200	1.22 fast.

While most of the companies give much attention to their meters, it is well to bear in mind a few conditions for the preservation of accuracy in properly made meters; first, careful handling; second, being set in places where the temperature is equable and not too high; and third, being used to measure only well purified gas. Tar, ammonia, oily vapor and sulphureted hydrogen are all liable to affect the continued proper working of the meters.

The gas supplied by the 70 companies was tested at irregular intervals during the year, no notice being given of an intended visit. The law provides two inspections yearly for each company and an additional inspection for every 6,000,000 feet of gas supplied, until the inspections become weekly. An inspection comprises the determination of the candle power, the amount of total sulphur and ammonia and the presence of sulphureted hydrogen. The candle power is taken by the Bunsen photometer, using a standard English sperm candle and the Bunsen disc. There are open and closed photometers, 60 and 100 inch bars and one and two candles used for a standard. Some of these photometers have been compared with the portable photometer and the results found to agree. The law prescribes as the testing burner that one which is best adapted to the gas under examination and at the same time suitable for domestic use, while burning at the rate of 5 feet per hour, as nearly as practicable. For the high candle power water gases the Sugg's table top 6 foot open burner is used; for the low candle power water gases, the richer coal gases and the mixed water and coal gases, the Sugg's improved London argand size F is used;

size D both old and improved argand is used for the poorer coal gases, while the oil and oil-air gases are tested with open burners ranging in capacity from ½-foot to 3 feet per hour. All candle power results are reduced to the legal rate of 5 feet per hour.

The sulphur, determined as total sulphur per 100 feet of gas, is found by burning the gas through a Bunsen burner in an atmosphere containing ammonia, condensing the products of combustion and analyzing the resulting ammonium sulphate.

The ammonia is determined by bubbling the gas through hydrochloric acid, of known strength, colored with cochineal, until the indicator changes color; from the strength of the acid and the amount of gas used the number of grains of ammonia per 100 cubic feet is easily found.

Sulphureted hydrogen is detected by holding a paper, moistened with basic acetate of lead, over an open burner for about 30 seconds, a brown or black stain showing the presence of this undesirable impurity.

The law requires the gas to be of 16-candle power, to have not more than 20 grains of sulphur per 100 feet of gas, or 10 grains of ammonia and no sulphureted hydrogen.

* * * * * * * * *

The following table gives the results obtained in analyzing some gases during the year, the last three being those used in connection with the calorimetric tests:

	Candle Power.	Illuminants.	Marsh Gas.	Hydrogen.	Carbonic Oxide.	Nitrogen.	Oxygen.	Carbonic Acid.
Boston.....	26.4	15.03	21.11	32.77	24.38	3 47	0.21	3.03
Chelsea	18.6	7.29	37.92	47 39	5.42	1.98	....	....
Norwood...	19.7	5.67	39.41	44.83 C_2H_6	5.60	4.27	....	0.22
Stoneham..	27.4	23.70	22.04	1.01 H_2	13.12	38.57	....	1.56
Boston.....	25.7	15.55	21.44	30.29	26.90	3.06	....	2.76
Charlest'wn	17.8	10.42	28.63	42.80	13.93	2.03	....	2.19
Newton ...	17.2	5.23	34.80	50.59	6.16	2.06	....	1.16

The Stoneham gas, specific gravity 0.700, was made by the Kendall process, which consists of blowing air, steam and oil into a firebirck lined generator. This process necessarily leaves a large amount of nitrogen in the gas and therefore requires large amounts of illuminants to counteract the diluting effect of the inert nitrogen.

Three more calorimetric tests have been made and the results are given in the following table:

Kind of Gas.	Newton. Coal.	Charlestown. One-third Water. Two-thirds Coal.	Boston. Water.
B.T.U. gross at 60° F. and saturated with moisture .. .	655.2	658.3	739.7
B.T.U. in condensed water....	56.0	44.7	50.0
Net B.T.U. at 60° F. and 30 in. barometer, saturated, being usual commercial standard; from experiment.....	599.2	613.6	689.7
Net B.T.U. of dry gas at 32° F. and atmospheric pressure....	644.2	650.0	741.5
Theoretical B.T.U. from analysis, dry gas at 60° F. and atmospheric pressure, gross...	661.6	662.2	738.6
Chemical formula for illuminants from analysis.....	$C_{2.91}H_{5.62}$	$C_{2.31}H_{5.18}$	$C_{2.51}H_{6.88}$
B.T.U. value per cu. ft. illuminants..... ..	2,357.0	1,794.8	2,154.0
Specific gravity of gas.....	.421	.507	.673
Candle power.....	17.2	17.8	25.7

The first figures give the results obtained from the calorimeter; from these gross calorific values were subtracted the amounts of heat absorbed from the condensed products of combustion, which in practice would go off in vapor. These values are the usual commercial values for the heat units of gas, being for gas saturated with moisture at 60° F. and the atmospheric pressure. The gases were analyzed in the usual manner with Hinman's eudiometric apparatus and then in a new portion of gas the carbon density, or ratio of carbon and hydrogen in the illuminants determined; from the composition of the hydrocarbons the heating values were calculated. The British thermal unit is the amount of heat required to raise 1 pound of water 1° F., so for Boston gas 1 cubic foot would raise 689.7 pounds of water from 60° to 61°.

Mr. Jenkins was assisted in the above inspections and experiments by the Assistant Inspector, Mr. L. S. James.

The Source of Light in Flames.[1]

[By. Prof. Arthur Smithells, before the Royal Institution, England.]

On Friday evening, March 12, Professor Arthur Smithells lectured on the above subject in the theater of the Royal Institution, where Faraday delivered his famous lectures on the chemistry of the flame of a candle, and where Frankland, in later years, expounded his theories of flame and the luminosity of flame. There was a large and brilliant audience; and Professor Smithells kept every one entranced for over an hour by a rapid succession of pretty experiments devised to force home the theories which he was expounding. To report such a lecture is a difficult task—an impossible task to do it justice—so much depends upon the experiments, which, of course, we cannot reproduce. Prof. Smithells first referred to the hydrogen and oxygen flame, and asked if there was any evidence to show that the steam, the product of the combustion, was made to glow by the temperature of the combustion. Answering the question, he said there was no direct evidence that steam could be made to glow by raising its temperature. Indeed, very little was known about the effect upon gases of a purely roasting process; but it was known that most gases can be raised to the highest possible temperature, by the most powerful means of heating known, without emitting any visible glow. But there were one or two exceptions. The vapor of iodine, when raised to a high temperature in a glass tube, was seen to glow with a peculiar light. But this might not be due solely to the gas being heated, in the ordinary sense of the word; it was just possible that some sort of chemical action was going on. Bromine and chlorine behaved in a somewhat similar way, emitting a certain amount of light when heated. There were then, apparently, some gases that could be made to glow when heated; but they were few in number, and did not include those gases commonly found in flames. One should, therefore, hesitate to assume that the light of the hydrogen flame is due to hot steam, in the ordinary sense of the word hot. When hydrogen united with oxygen they had to deal with a chemical change in which much energy was set free or became kinetic. It was impossible to picture the process that was going on with any certainty of detail. When the molecule of hydrogen approached the molecule of oxygen, an action took place which made active a large amount of energy formerly latent, and there existed between the molecules a state of things which made it impossible not to believe that it must result in motion of a peculiar kind, characteristic of the process; and one would imagine this motion to be vibratory, and therefore capable of producing light. In that state, then, it was conceivable that hydrogen might emit light, not in the sense of producing hot steam, but in the act of the formation of a new compound: That the light might be due to the chemical and not to what they would call the heating process. The light might be due to molecules vibrating otherwise than as a result of high temperatures. If the molecules were kept sufficiently far apart, it was possible to get light without sensible elevation of temperature.

A well known example of this was given by phosphorus vapor diluted with a neutral gas, which gave a cool green flame. To what was the light of this flame to be attributed? The chemical process taking place was the formation of the phosphoric oxide. Now, phosphorus was a substance that ignited at a very low temperature, and so it was possible to introduce an enormous number of indifferent molecules without cooling the flame below the temperature at which phosphorus ignited. But it was impossible to obtain a hydrogen flame which was cold. The temperature could certainly be reduced by introducing indifferent gases, but a cold hydrogen flame could not be obtained, for they would very soon reduce the temperature below the point at which hydrogen would ignite. The hydrogen flame consisted of a hot shell of combustion. Was it not of sufficiently high temperature to heat the unburned gas within so that it might glow as iodine did? This was formerly thought to be the case.

Observations on the flame of hydrogen led to the belief that the spectrum observed included the spectrum of hydrogen itself, but Professor Liveing's experiments decided the matter in the negative. The light of the hydrogen flame had since been examined with great care, and it had been agreed that the spectrum was the spectrum of water. Now, the light emitted by the hydrogen flame was very feeble. Why? This was the kind of question which inspired the work of Davy and Frankland. Davy's curiosity was aroused by the observation that a mixture of inflammable gas and air in the safety lamp produced a pale blue flame very different from the flame given by coal gas when burned in an ordinary burner. He made some very simple experiments, and came to the conclusion that the light of coal gas was due to

1. From the *Gas World*.

the deposition of solid particles of carbon in the interior of the flame. In 1867 Dr. Frankland came to the conclusion that Davy's theory could not be maintained in its entirety. Dr. Frankland showed that bright flames existed that did not contain solid particles; that the luminosity of flame appeared to depend upon the density of the gases; that luminosity could be obtained by compressing the gases; and he maintained that the luminosity of ordinary hydrocarbon flames, such as that of coal gas, was not due, to any appreciable extent, to solid particles, but to dense hydrocarbon vapors. Of these propositions two had been substantiated. Bright flames undoubtedly existed in which there were no solid particles; phosphorus and carbon bisulphide gave the brightest flames known, and they could contain no solid particles; and gas that burned in the ordinary way with a feeble light would give a brilliant light when burned under pressure.

[The lecturer proved this latter point by igniting a mixture of oxygen and hydrogen in a eudiometer tube, when a bright flash of light was produced under the pressure resulting from the combustion.]

As to the relation between density and luminosity, the lecturer gave the following table of densities from Dr. Frankland's paper, saying that the correspondence between density and luminosity was indisputable:

Hydrogen	1
Steam	9
Chlorine	18.25
Carbon monoxide	22
Sulphur dioxide	32
Arsenic trichloride	91
Phosphorus pentoxide	142
Arsenic	150
Arsenious oxide	198

Continuing, Professor Smithells said there were exceptions, which Dr. Frankland had recognized from the first; but it was possible to get over these difficulties by considerations of temperature. It could generally be shown, for example, that the very luminous flame given by a gas of low density was exceedingly hot, and it might be shown, on the other hand, that a non-luminous flame which contained a dense gas was probably abnormally cool. He did not think that the conclusion drawn from burning gas under pressure was any rational confirmation, for two gases could not be called comparable when they had the same density. In the first case the property appertained to the molecule itself—it was the heaviness of the molecule and not the heaviness of the gas—that had to do with the luminosity. In the second case it was the crowding of the molecules together that increased the luminosity. He was in disagreement with the inference drawn by Dr. Frankland that these two sets of facts were of the same order.

If the bright flame of phosphorus hydride were taken, the hydrogen might be supposed to burn with a non-luminous flame, and the phosphorus burned with a very bright light. But when the flame was cooled by the addition of carbonic acid, a green light was got, which the lecturer attributed to the formation of phosphoric oxide. But as you cut off the carbonic acid or increase the supply of phosphorus hydride the flame gradually acquired a bright luminous glow, and the characteristic of that glow was that it could be reduced by reducing the general temperature of the flame. They were therefore led to the conclusion that the green light was due to the chemical union and the white light to the temperature. The phosphorus oxide got baked and roasted, and then it gave a secondary light. But it might be that part of the glow was due to phosphorus. That this was not so could be shown in several ways. If air were introduced into the middle of the flame the amount of phosphorus oxide formed was increased, but instead of the flame becoming duller it became brighter. Nor could there be any question of solid particles, because, when the sun's rays were focussed upon the flame, none of that scattered light was got which was held to be a sure test of the presence of solid particles.

In the flame of hydride of silicon they had very much the same conditions. When this flame was cooled by the addition of carbonic acid it became almost non-luminous; but on holding a Bunsen flame above it so as to catch the product of combustion a long luminous cap appeared above the non-luminous flame, due to the incandescence of silica. [This was shown by experiment.] The cooling and deluminating effect of carbonic acid upon the flame of acetylene was next shown and the question was asked, "What is it that glows in a hydrocarbon flame?" The choice lay between carbon itself and some hydrocarbon. That would seem to be a question that could be answered with tolerable ease. A deposit of soot could be got from such a flame. What was soot? Analysis showed that it corresponded with neither carbon nor a hydrocarbon. Analysis of soot always showed a certain percentage of hydrogen, but so small that it seemed almost impossible to suppose the hydrogen and the carbon united in the ordinary chemical sense. Recent analyses of soot showed only 1.4 per cent. of hydrogen, while the most highly carbureted hydrocarbon recognized contained about 5 per cent. of hydrogen. That soot could therefore contain only 30 per cent. of such a hydrocarbon, whilst 70 per cent. was carbon. Therefore, they must conclude that the light was due mainly to carbon, or that soot was a unique hydrocarbon, about which nothing chemically definite was known, and which possessed highly peculiar properties. It was therefore impossible for the lecturer to come to any other conclusion than that the source of light was the carbon itself. Then in what condition was the luminous substance—solid or gaseous? If the optical test, concentrating light upon a flame, was valid, then Professor Smithells thought there could be no doubt that hydrocarbon flames contained solid particles. No hydrocarbon flame was known which did not show solid particles when light was concentrated upon it. Therefore he concluded that Davy's original explanation was correct, that the luminosity of hydrocarbon flames was due to solid particles of carbon separated in the middle of the flame and highly heated, the light coming from these, as Davy said, partly by ignition and partly by combustion.

The non-luminous part of the flame was much more interesting, and more controversy had raged over it. For its study they turned to spectrum analysis. A hydrocarbon flame produced carbonic acid and steam, and the chemical process took place in two stages. When the two cones of the flame were separated (which Professor Smithells did very neatly and expeditiously) the gases between the two could be extracted and analysed. Such an analysis, in the case of an ethylene flame, gave the following results:

Carbonic acid	3.8
Steam	9.5
Carbon monoxide	15.3
Hydrocarbon	0.8
Hydrogen	9.5
Nitrogen	61.1

The most important point in this analysis was the large amount of carbon monoxide, which seemed to show that this substance was the first product of oxidation—a result made almost certain by the researches of Professor Dixon and his pupils. If that were so, it was a very important conclusion, for it led them to associate the light of that part of the hydrocarbon flame with carbon monoxide. Every hydrocarbon behaved in the same way. He thought he might say that the result of impartial observation of the subject, from the flame point of view, was that the peculiar quality of the light that gave rise to what is known as the candle spectrum was associated with the formation of carbon monoxide in the same way as the hydrogen flame was associated with the formation of steam. It was almost heretical to say so, but he ventured to think that this spectrum was the spectrum of carbon monoxide. The difficulty was that carbon monoxide had been already provided with a spectrum. Certainly as good a case could be made out for this spectrum being due to carbon monoxide as to carbon itself, and a much better case for it being due to carbon monoxide than to hydrocarbon, and he hoped to be able to produce before very long the evidence upon which he relied for this. The cyanogen flame was the only flame in which carbon was not associated with a combustible element, and therefore it was a much simpler study than was a hydrocarbon flame. When the cyanogen flame was divided, and the interconal gases analysed, the following results were obtained:

Carbonic acid	0.5
Nitrogen oxides	0.8
Carbon monoxide	25.5
Nitrogen	65.8
Cyanogen	7.4

The first step in the combustion of cyanogen was the formation of carbon monoxide—a fact of considerable significance, because the flame gave distinct evidence of that same spectrum which was attributed to carbon itself. If cyanogen was burned in oxygen, then the flame became brighter and the spectrum became more pronounced. Here, again, was seen this spectrum associated with the production of carbon monoxide. The production of carbon monoxide in this flame of cyanogen could be demonstrated in a special way. If the gas was dried and the cones widely separated, the outer one was extinguished when introduced into a bottle of dry air. This was in accordance with the behavior of carbonic oxide as discovered by Prof. Dixon.

The lecturer said he had not time to enter into the question of the precise mode in which carbon was separated from flames. Professor

Lewes had put forward an ingenious theory, attributing the separation to the formation and subsequent decomposition of acetylene. He was not in agreement with Professor Lewes on the subject, but he hoped to discuss the question elsewhere.

In conclusion, Professor Smithells alluded to the luminosity of flames arising from the introduction of the vapors of metallic salts. This subject was full of difficulties and anomalies, and its exploration demanded much time and trouble. He had made some progress, but he could not do much more than illustrate the kind of problems that had to be dealt with. This he did by experiments with the flame-cone separating apparatus.

Does the Manufacture of Sulphate of Ammonia Pay in Small Works?

[A paper read by MR. J. WILKINSON, of Drighlington, before the Manchester District Institution of Gas Engineers.]

The recent low prices realized for sulphate of ammonia have created contention among gas managers as to whether or not its manufacture at small gas works is a profitable undertaking. A few remarks upon the subject may, therefore, be worthy of consideration. We will take a gas works carbonizing 5,000 tons of coal per annum as a fair average example. The Drighlington works, with which I am connected, carbonize that quantity of coal; and the prices and results there obtained may be taken as reliable figures for comparison. During January last the price of sulphate was $40 per ton, f.o.r. at Hull; and the value of 10-ounce liquor being then quoted at $1.37 per ton, these prices are taken as the basis upon which the calculations are made.

The cost of manufacturing 1 ton of sulphate may be stated at $17.87, comprised of the following items:

17½ cwt. of acid (B.O.V.) at $10 per ton	$8.75
12 " coke at $1.25 per ton	75
4 " lime, at $3.16 per ton	63
Labor, including packing	2.02
Carriage from works to port	2.33
Bags, 8 at 7 cents	56
Brokers' commission and discount (2½ per cent. on $40)	1.39
5 per cent. depreciation on cost of plant	72
5 " interest " "	72
Total	$17.87

Deducting this amount from $40 leaves $22.12 as the net receipts per ton of sulphate sold.

The yield of sulphate at the Drighlington works averages 33 pounds per ton of coal carbonized; 5,000 tons of coal producing 74 tons of sulphate. Taking 32 gallons of 10-ounce liquor (218 gallons = 1 ton) as the average yield per ton of coal carbonized, 5,000 tons of coal will produce 734 tons of liquor. Summarized the results give—

5,000 tons of coal yield 74 tons of sulphate at $22.12 per ton = $1,637.25, or 32.44 cents per ton of coal carbonized.

5,000 tons of coal yield 734 tons of 10 ounce liquor at $1.37 per ton = $1,009.25, or 19.38 cents per ton of coal carbonized.

Balance in favor of sulphate upon 5,000 tons of coal = $628, or 12.60 cents per ton of coal carbonized.

Certainly the amount of profit does not appear to be a great one, and could possibly be overlooked by the managers of large gas undertakings, or those who enjoy a good price for their gas. But at many small works (as in my own case) it means a difference to the dividend, and well repays any attention devoted to it.

Having dealt with the financial part of the subject, we may with interest turn attention to the two systems of distilling liquor now in use, viz., the continuous and the old-fashioned intermittent. Each system has its advocates, and doubtless both of them possess advantages and disadvantages. Seeing that both systems are so well known to gas managers, it is not proposed to give descriptive particulars of either, but simply to compare the two methods of working and the results obtained by each. Commencing with the continuous system, the advantages are generally stated as follows:

1. That by driving off the ammonia from ammoniacal liquor by means of live steam, an increased yield of sulphate is obtained.
2. Reduced fuel account.
3. Complete control over the waste gases from the saturator, with less cost for purification.
4. The plant can be started and let down at short notice.
5. Simplicity of working, with less cost for attention.

Dealing with the first advantage claimed, it will at once be seen that, if the principle of heating the liquor with live steam be correct, it must necessarily follow that the yield of sulphate will be the highest it is possible to obtain. We must therefore take the returns of sulphate made as the basis upon which to consider the principles involved. It will be admitted that one thing essential for efficient sulphate making is heat; the higher the heat you maintain in the still, the more certain you are that no ammonia, either fixed or free, is left in the spent liquor. The same applies to the saturator. If there be not sufficient heat, the sulphate is fished out in a wet soapy condition, and will not dry, the color is altogether bad, and large clots of black matter will have settled down along with the sulphate.

Assuming that the principle of driving off the ammonia by means of steam is correct, we find that in the continuous system the steam is generated in an ordinary steam boiler, and then conducted a variable distance and discharged into the still at a pressure of 10 to 15 lbs. per square inch. It is easy to infer that in travelling through pipes the steam will have to some extent condensed, and probably enters the still at a lower temperature than the steam inside the boiler. Turning aside to the intermittent system, the still there employed is simply the boiler used to generate steam for the continuous still. In other words, fire is applied direct to the still filled with liquor, and ammonia is being driven off at the same time as steam is generated; both travelling together the shortest possible distance from the still to the saturator. Here we have steam being generated from the liquor itself—nascent steam, as it were, ready to attack the ammonia compounds at the most favorable opportunity, and breaking up their combination with the highest possible evolution of ammonia. In support of the above remarks, practical experience has shown a difference of 2 to 3 lbs. of sulphate per ton of coal carbonized in favor of the intermittent system—viz., intermittent, 33 lbs.; continuous, 30 lbs. Also records of the temperatures noticed in the stills and saturators, indicate that the greatest heat is obtained in the intermittent system (see figures below).

Temperatures of Gases in Still.

Continuous system	210° to 212° F.
Intermittent system	216° to 222° F.

Temperatures in Saturator.

	Mother Liquor.	Waste Gases.
Continuous system	210° to 225° F.	210° to 215° F.
Intermittent system	210° to 230° F.	212° to 220° F.

To combat against these statements, there is the contention put forth by advocates of the continuous system, that the spent liquor shows a smaller percentage of ammonia than the spent liquor from an intermittent still. But when testing in the laboratory to find this low percentage, the intermittent system is used on a small scale. The liquor, being mixed with caustic potash or lime, is placed in a flask and evaporated by means of a Bunsen burner; and if a gas jet is capable of driving off all the ammonia from liquor contained in a flask, what is there to prevent a coke fire doing likewise in the case of liquor contained in an intermittent still? A line must, however, be drawn; and, if the last traces of ammonia are eliminated, the cost of the extra fuel used will amount to more than the value of the small portion of ammonia gained—more especially at the present low price of sulphate.

Turning now to the fuel account of both systems, it must be admitted that the hot waste gases from the saturator of a continuous still are turned to excellent account when, by means of the heater, the inflowing liquor is heated to a temperature of 160° to 170° F. The same advantage could be gained with the intermittent system. It would, however, require an extra storage cistern equal to the capacity of the still; and although I am not in a position to say what saving would be effected, it is very probable that the fuel account of the intermittent system would be reduced below that of the continuous system. The coke used per ton of sulphate produced may be stated for the continuous still at 10 cwt., and for the intermittent still at 12 cwt. It must also be conceded that the cost of purifying the waste gases is in favor of the continuous system. Owing to the flow of liquor being constant and at a fixed rate, the volume of sulphureted hydrogen given off is regular. But during a certain period of the distillation by an intermittent still, sulphureted hydrogen is given off in large volume; and increased purifying capacity must be provided to cope with the gases at this particular stage.

It is stated that a continuous plant can be started and set down at short notice. But I fail to see any great advantage in this, as the intermittent plant can also be started at any time, and will not require to be set down until the distillation is complete. It is, however, possible for

the saturator, or any part of the plant beyond, to go wrong; and should this happen with an intermittent plant before the distillation is completed, a certain amount of ammonia would be given off from the hot liquor and lost. But I may say that, during ten years' working of an intermittent plant, no such case has occurred.

Dealing with the last claimed advantage—simplicity of working, with less cost for attention—I can speak from experience with both the systems; and in my opinion the continuous plant is far more complicated in construction, and more difficult to manipulate, than the intermittent. Older managers, with experience only of the intermittent system, tell us that the process of sulphate making is very simple, and requires practically no skilled labor; but managers, even of large works, who have adopted the continuous system, are rapidly finding out that sulphate making is not so simple as they anticipated.

Taking an external view of a continuous plant capable of dealing with (say) 20 tons of liquor per day, we at once notice the apparent elaborate construction of the apparatus—steam boiler with the usual fittings and reducing valve, still with water gauges and 25 to 30 handholes for cleaning out purposes, baffle box with siphon overflow, heater, balance tank and overhead cisterns, etc. An internal inspection reveals a series of trays or hoods, with serrated edges, overflow pipes, perforated plates and liquor heating tubes. All of these require a certain amount of attention beyond the usual routine work of the sulphate maker; and yet it has been said that the man in charge of a continuous plant has plenty of spare time on his hands, which could be filled up with other work.

Notwithstanding that the apparatus appears to have been so well designed, considerable trouble is experienced in the working, chiefly owing to the overflowing of the liquor from the still into the saturator, with the formation of blue sulphate. This so-called priming may be caused in several ways. The liquor constantly flowing through the still leaves a deposit in the form of scale, very similar to what is found in steam boilers; and the scale, becoming detached, is very apt to block up any of the overflow pipes. This frequently occurs in the free ammonia chambers, with the result that the inflowing liquor collects in the still above the stoppage, and either overflows or is forced over into the saturator by the pressure of steam and gases which have collected below the stopped overflow. Pumping too large a quantity of cold milk of lime into the liming chamber occasionally produces the same effect; and collection of salt over the snore pipe in the saturator, or cold liquor flowing into the still, also causes the liquor to be forced over. These usually occur immediately after the saturator has been charged with acid; the cold acid condensing the steam and hot gases to the extent that the pressure is reduced below what is necessary to force the sulphate forward into the fishing box. At the same time a reduced volume of waste gases at a lower temperature circulates round the liquor tubes inside the heater, and consequently the inflowing ammoniacal liquor is not heated to the desired temperature. Probably both these defects would be overcome by using an increased quantity of steam at a higher pressure; but this, of course, means an increase in the fuel account. In addition to causing blue sulphate, priming of the still is also a source of danger to the sulphate maker. The liquor rushing over into the saturator will occasionally force the hot acid out of the fishing box; and I know of several narrow escapes from being scalded. It may be urged that this does not often occur, but the risk is still there, and the erection of perforated plates inside the baffle box does not always overcome the difficulty.

In the intermittent system, the camber bottomed still takes the place of the steam boiler, still and heater used in the continuous system, with all the various complications. There are no internal fittings to get out of order and cause trouble, and no priming of the still (producing blue sulphate of reduced value); but year after year the highest returns of sulphate of the best color and quality are obtained with the utmost simplicity in working, which is practically the boiling of a huge kettle filled with ammoniacal liquor. There is also the question regarding the cost of plant; but it is not intended to compare the matter of cost, further than to state that an intermittent still will not be half so costly as a continuous still with its various accessories.

In conclusion, it may safely be said that the working up of ammoniacal liquor at the place of production is certainly the best means of dealing with it profitably, and that the intermittent still (fired hard) is the most efficient method to adopt at small gas works.

Discussion.

Mr. R. G. Shadbolt (Grantham) moved a vote of thanks to Mr. Wilkinson for his interesting communication. The paper, he thought, answered its own question. The author had said that the manufacture of sulphate of ammonia in small works paid, because at Drighlington they obtained a return of 12 cents per ton on the price of coal carbonized. He could scarcely see why 12 cents per ton was less desirable in the case of large works than in small ones.

Mr. Isaac Carr seconded the motion. There was, however, a great deal in the paper with which he did not agree. Some of the figures in it were quite "eye openers" to many of those present. The author gave a return of 33 pounds of sulphate per ton of coal with the intermittent system, and 30 pounds with the continuous process. He (Mr. Carr) would like to know how many persons there were in the room who, working on either the continuous or intermittent system, reached the latter figure. Certainly, under normal conditions, he had never been able to do it—working with as good a form of plant as any he knew of. The question of make per ton resolved itself into that of the quantity of nitrogen in the coal; and he would like to know where Mr. Wilkinson got his coal from, what percentage of nitrogen it contained, and what was his make of gas per ton. An answer to these questions would furnish some guide as to the temperature at which the coal was distilled. This, of course, had a great effect upon the yield of ammonia, as they all knew that if the coal was distilled in iron retorts at a very low temperature, they would get a large increase of ammonia. But they also knew that this did not pay. He did not agree with the author's remarks as to the cost of working a continuous plant. He had worked for a good many years in the North of England with an intermittent plant, and was at present working a continuous plant. The cost of attendance was, from his experience, enormously in favor of the last-named system. At the present time he was making about 200 tons of sulphate of ammonia per annum, and the plant did not require the whole of one man's attention, which showed that the continuous system could be worked very economically. They had all the latest improvements in dischargers, etc., there being practically no manual labor required in connection with the operation of the plant. With regard to the intermittent process, in boiling the liquor, he might mention that they could never succeed in getting the waste liquor down to anything like so low a percentage of ammonia as was obtained in any ordinary continuous still. Whether this was due to local circumstances, he did not know; but he would like to ask the author what his effluent liquor came out at.

Mr. C. E. Jones (Chesterfield) said, with regard to the production of ammonia, they must know something of the coal itself and the temperature of distillation. Some coals yielded 12 gallons of ammoniacal liquor per ton, and others as much as 126 gallons; so that, befor instituting a comparison, they ought to know what kind of coal Mr. Wilkinson was using. Some coals mined in the North yielded very little nitrogen, while others in the Midland counties yielded four times as much nitrogen. They wished to know the quality of the coal used by the author, and the mode of carbonization. With regard to converting or extracting the nitrogen from the liquor, he rather thought circumstances were against the theory of the author. Personally, he had used both the intermittent and continuous processes, and he was decidedly in favor of the latter. The intermittent system was a very wasteful one. They could not, by using it, extract all the ammonia out of the liquor, except by taking very special means, which it did not pay to adopt. He always advocated the constant system, by which every unit of heat was available for the purposes of the operation. At the present price of sulphate of ammonia it would scarcely pay small works to put down apparatus for its exclusive manufacture, as this would not be employed more than one-third of the year. He very much questioned whether at small works they could not make all the sulphate from their ammoniacal liquor in two months' continuous working; and the apparatus would be lying idle during the remainder of the year, eating itself up in interest. The paper, however, opened up many questions of considerable interest to managers of small works.

Mr. Harrison Veevers said that, taking his own district, he found that, although the details as to sulphate manufacture were somewhat different from Mr. Wilkinson's figures, the total result was almost the same. The question of sulphate manufacture depended largely upon their situation as regards the market for ammoniacal liquor, as the liquor had in many cases to be sold at a low cost on account of the heavy carriage. Mr. Wilkinson allowed $1.37; but he (Mr. Veevers) was getting $1.87. If he had been still further away from the market, he would only get about $1.37, or even 87 cents. Still the railway carriage would not be proportionately so great for the salt as for the liquor. The cost of manufacture was about $17.50 per ton; and, taking the cost of the liquor at $1.75, and 10 tons of liquor for one ton of sulphate, this would make another $17.50 per ton—making a total of $35 per ton. This embraced items mentioned by Mr. Wilkinson, and also others

as well—including the duty of 3 guineas a year on the still. They obtained in this way $5 per ton clear profit, the cost of the manufacture and value of the liquor being $35 per ton. So that, making 70 tons a year, they got $350 per annum clear profit; and this showed it paid them to make sulphate instead of selling the crude liquor. To show that this was advisable for small works, he might say that the cost of boating the liquor from his place to a manufacturer would be $300 per year, which was money clearly lost so far as the sulphate was concerned. Then again the maker had to have his profit; so that, taking the $300 or so saved in boating, and $50 maker's profit, there was a clear gain, as he had said, of almost $350 per annum, which his works was now making.

Mr. W. Carr said he had never been able to produce 33 pounds, nor even 30 pounds of sulphate per ton of coal. When working at Halifax some years ago, with an intermittent plant, he was told he was getting about the highest result in Yorkshire, and this was 26 to 27 pounds per ton of coal. Some Lancashire makers were doing better, but this was owing to the fact of the coal they used having a higher percentage of nitrogen. He would like to know what coal the author was using, and the percentage of nitrogen. As to small works, the author had given him food for consideration respecting the intermittent plant. A continuous plant of small size was apt to become very expensive. It might be profitable for large outputs, but for small productions there was a good deal of waste heat, and extra cost for labor and in other respects. He could quite conceive that an intermittent plant might be much more serviceable in the case of a low make of sulphate; and as he was interested in one or two small works where they could not get $1.75 per ton, or even half that amount, for the liquor, he should consider carefully whether an intermittent plant might not be of service to them. They did not know whether they had reached bottom prices for sulphate of ammonia, and if these fell to any great extent, it might not pay makers to give anything for the liquor. His committee had been deploring the fact that they were not successful in selling their liquor, and he had told them that if the price fell another $5 per ton, there would be no value at all in it. He ventured to say that the persons who paid $1.75 per ton were losing money on every ton they took. With the present price of sulphate, the liquor had no such value as $1.75 per ton.

Mr. E. Jones (New Mills) said the question depended largely upon the price obtained for the liquor and the situation of the works. His works were constructed at a very low part of the town, and his tar and liquor cost 75 cents per ton to send to the railway station, while they were far removed from the tar distillers. The paper would therefore place him in a better position to instruct his Committee as to whether or not it would pay to make sulphate.

The President said if they could get 12.06 cents per ton on the coal carbonized by making the sulphate, no doubt many of them would take up the matter. He should like to know what method Mr. Wilkinson had of extracting ammonia from his gas, and also the amount expended on plant for making sulphate from the 5,000 tons of coal.

The vote of thanks was carried with acclamation.

Mr. Wilkinson, in reply, said 33 pounds per ton of coal was not the best result he had achieved; he had obtained as much as 34 pounds for a full year's working. The coal he used was the ordinary Yorkshire seam known as Mirfield black bed, which was a seam that no gas manager would use if he could help it. He had not ascertained the percentage of ammonia contained therein. As their make of gas was from 10,200 to 10,300 cubic feet per ton, there was no question of low heats, etc., in their case, so that they could scarcely obtain anything from that. The cost of labor at the Widnes works was evidently very small; but, personally, being a practical sulphate maker, he did not want to return to a continuous plant, as there was always something on the mind of the attendant, and if he had anything else to look to, there was generally a mishap with the continuous plant. As to percentage of liquor, he had tried it scores of times, but had never seen any practical difference between the continuous still and the intermittent process. Mr. Jones had said that in a continuous plant every unit of heat was utilized. This was not so. Directly the steam left the boiler, there was a certain amount of heat lost by condensation and radiation. [Mr. Jones: It depends upon the distance it has to travel, which in my case is only 2 yards.] Mr. Jones thought it did not pay to work up the liquor. But he (Mr. Wilkinson) looked at it in the light that in any case they were offered a certain amount for the liquor, and no one would give more than this. But if they had a sulphate plant, they were sure of getting the market value. There were so many "rings" among liquor dealers, that it was a question of whether they would not soon require something to carry it away; and this was the reason they had put down the sulphate plant at Drighlington. As to washing, they had one scrubber, and they did not take all the ammonia from the gas. He thought that as the price of ammonia was so low, it paid to allow a certain percentage to go forward to assist the purification. The cost of the plant capable of dealing with 10 tons of liquor per day was $1,050.

Correspondence

[The JOURNAL is not responsible for the opinions expressed by correspondents.]

Mr. Lloyd Points the Difference between Fair and Unfair Criticism.

THE WESTERN GAS CONSTRUCTION COMPANY,
FORT WAYNE, IND., March 23, 1897.

To the Editors AMERICAN GAS LIGHT JOURNAL:

I am accorded so much and prominent attention by your esteemed contemporary, Progressive Age, in its issue of March 15th, that I think I must feel something as did Mr. Highlands after his remarks about the "Ghastly Welsbach Light." Certainly, no fault can be found with Brother Brown's generous distribution of hard knocks among the gas engine builders.

To be serious, however, the paper attacked was presented, at the request of the Ohio Association, as a practical talk to practical men on a very live subject, to show the reasons for the limited powers of the present types of gas engines, and the direction for, or next step in their evolution; and had it been fairly criticised within its scope no one would have felt greater pleasure in reading such criticisms than the writer. But to be attacked for no other reason than because the Company with which I am associated did not, for reasons evident to any sane individual, exhibit such an engine as the paper described at the recent Gas Exposition, is an infection of "New Journalism" into the technical press that we may hope will not spread. Such an engine weighs, in one connected piece of machinery, some 17 tons, and has an 8-inch exhaust pipe, the noise from which, unless properly muffled, is like that from a fair size cannon, and to have installed it and its connection in the very limited time at disposal for getting the exhibit in place, even to have put it in as a "dead" exhibit, would, for the time being, have monopolized a good share of the floor of the Madison Square Garden. To have installed it as a running exhibit would have necessitated a heavy masonry foundation, out of the question to build and be set in a night. Trouble is said to have been experienced at the outset with the little engine which ran the light exhibit from this cause, and the well known liability of engines to explode in the air chamber, when running below speed under throttled supply, was made manifest in the other engine on exhibition. Such happenings in a small engine might not be noticed outside of its immediate vicinity, in a crowded hall with a great deal of noise necessarily going on; but if a 100-horse power engine were to express its sentiments in that way the management of the show would not have remained passive. These reasons militating against the exhibition of such an engine were carefully and fully explained to the managing director, but he wanted engines badly, and, like Lord Nelson, he looked at the argument with his blind eye.

A 17-ton gas engine is not a toy to tote about the country for 10-day shows, where 99 out of 100 people who would see it would be no wiser afterwards than before, and the remaining one in the hundred who would understand it and who could make use of it, is furnished with means for becoming fully acquainted with it through the advertising columns of his technical literature, and otherwise.

To revert to the criticisms, so-called, and the objections raised, first, to my method of classifying engines and asserting that there are five cycles (Clerk, the best of authority, says *three*), he then goes on to observe that, "For large and important work *all, excepting the Otto, are obsolete*." The purport of the paper being to deal with the question as it is alive to-day, and not to spin a yarn over dead and forgotten cycles, nor soar above the clouds of the future, the Otto only was mentioned.

The distinction between single and double-acting engines may be microscopic in the eyes of friend Brown, but to those who are posted on the subject it means at once many things impossible in the single-acting type. Clerk again says, as the *next step* in advancement beyond present practice, "Means must be found for making it (the gas engine) double-acting." So great an authority foresaw the line of development. My Company is employing with success one means that has been discovered; I am not so "childish" as to presume there will be no other methods. It is true that two single-acting cylinders accom-

plish the same result as one double-acting, but a 250-horse power gas engine, single-acting, has a 30-inch cylinder, and what steam engineer ever advocated using two such cylinders for a 500-horse power engine, when closing in the front end would obtain the result? And, furthermore, is there an important single-acting steam engine that is not vertical; and is there an important gas engine that is not horizontal? Whether in the future they may be twisted around, it was not the purpose of the paper to speculate upon; it was dealing with what is at present and is looked for in the reasonably near future.

It is true that 99 out of 100 gas engine designers follow the single acting plan, if it is admitted that there are but 100 builders of gas engines. Why they follow it was not for me to explain, and the single-acting engine in small sizes for general purposes is unquestionably simpler and more desirable than the necessarily more complicated double-acting type, and the paper so admitted; *but we were talking of large engines.* Can it be that Mr. Brown knows, of the temperature attained in the cylinder of a gas engine, what the effect of extreme heat is on iron and the difficulty of lubrication in such heat, and yet toss off the reason for single action as a commercial and not a mechanical matter?

Mr. Brown exhibits a lamentable ignorance for the conductor of an expert journal, when he tackles the question of government and asserts that regulation does not exist. If the gas engine is to be used for electrical purposes it must be regulated, and that very closely. He assumes it to be *solely* a question of flywheel, which it is not; because, to paraphrase his argument: "The very fact that the governor has three strokes during which to decide what to do on the fourth," is argument that "*an extremely sensitive* device *is imperatively necessary.*" It is true that with one impulse in four strokes the problem of regulation *is an extremely difficult one at best*, and I am sorry that Mr. Brown did not see that doubling the number of these impulses reduces the weight of flywheel necessary to average up the rate of turning, besides halving the problem of governing. As to whether these engines do regulate, that I leave to the users of them, who certainly ought not to commend a bad article.

I thank Mr. Brown for his even very meager commendation of my argument for establishing a different method of *comparing* efficiencies to that generally in use, and I suppose his strange misconception of the evident meaning of my remarks is but part of the inspiration of the entire article. To have gone into a question of thermodynamics would have taken more of the Association's time than it had to give to the subject, besides being outside the scope of the paper. But if a practical man has to choose between two engines, or has an engine in front of him which is not performing up to well known standards, or which he does not think is doing so, he will be told by the indicator how the engine obtains its results, or what adjustments are necessary to get the best results out of it; and he will do this even though he has but the most limited knowledge of the theoretical side of the question. This may be "childish," but I do not yet think so.

No particular mention was made of foreign practice, because it would cover too great a field, and the data respecting the efficiency of the largest engines is not sufficiently reliable or complete to base statements upon; but if Mr. Brown, who certainly has the most excellent opportunities, has access to information on these points, he will find an eager audience. And, finally, as to the points which Mr. Brown considers important before all others, viz., the starting of a gas engine under full load and the possibilities of compounding them—they were ignored for the excellent reason that they exist only in the "stamping ground" of the theorists, and will doubtless be found along with his "fifth cycle." There is no starter of pronounced success other than steam or compressed air, and the great minds to whom Mr. Brown refers are stumped as to the question of compounding, and, while well knowing the losses, give no practical suggestions of how to conserve them.

The writer does not set up to be a "great mind" on the gas engine business, but to be only one of the many manufacturers who is giving his best energies to applying those things which wiser people may find out and permit him to employ to the advancement of the gas industry and the fraternity of gas men. Were such an article to be taken seriously, it would be a backward step in our industry, that is now awakening to the possibilities in it. This article, with another of the same tenor in the same issue, but go to show how much misdirected may be the efforts of an editor in the conduct of a technical paper.

Yours truly, E. F. Lloyd.

The Pennsylvania State Senate has affirmed the reappointment of Mr. James W. Patterson, of Pittsburg, to the position of Inspector of illuminating gas and gas meters for Allegheny county.

ITEMS OF INTEREST FROM VARIOUS LOCALITIES.

The steamship Campania, which sailed from New York for Europe on March 27th, carried at least two gas men, in the respective persons of Mr. John S. Bush, President of the Northern Gas Light Company, of New York city, and Mr. Frederick Egner, of Norfolk, Va. Mr. Egner's trip is taken for the purpose of examining the working of the gas operated street railways of Colmar and Dessau, and to examine critically the latest European examples of carbonizing coal under the inclined retort system.

A correspondent forwards the following under date of March 26th: "At a meeting of the Winnepesaukee Gas and Electric Light Company, of Laconia, N. H., held in the office of the Laconia National Bank, the following organization was perfected: Directors, Chas A. Busiel, John T. Busiel, Albert G. Folsom, Chas. L. Pulsifer, Edward F. Burleigh, Samuel B. Smith and Henry J. O'Dell; President, Charles A. Busiel; Clerk and Treasurer, N. J. Edgerly; Superintendent, J. H. Bledsoe. A resolution to put the gas rate at $2 per 1,000 cubic feet was also adopted. This Company is the successor to the Winnepesaukee Gas and Electric Company, the properties of which were recently sold at receiver's sale."

Superintendent Gibbons, of the Coatesville (Pa.) Gas Company, has been authorized to make extensive additions to the Company's main system.

At the annual meeting of the Sewickley (Pa.) Gas Company, the following officers were chosen: Directors, W. L. Standish, R. J. Murray, R. B. Boobyer, C. C. Woods, C. T. Harbaugh, C. F. Nevin, J.W. Vraig, F. M. Love and W. A. Way; President, W. L. Standish; Vice-President, R. J. Murray; Secretary and Treasurer, S. H. Anderson.

The business offices of the Independence (Mo.) Gas and Coke Company have been established in Music Hall Block, a change that is sure to be appreciated by its officers and customers.

During this month every householder in Auburn, N.Y., who purchases a gas range of large size will be entitled to the free use of 10,000 cubic feet of gas.

Poughkeepsie, N.Y., has a Mayor, whose name is Hull. The Mayor somehow managed to conceive the idea that the Poughkeepsie Gas Company was charging exorbitant prices for the gas supplied to the inhabitants, and he had a bill drawn for presentation to the legislature, arbitrarily naming $1.35 per 1,000 as a fair rate for gas in that city for the future. The Company naturally demurred, and the result was a conference, which resulted in the following agreement between the Company and the authorities. The gross rate was fixed at $2 per 1,000 cubic feet, prompt payment to entitle the consumers to the following discounts—the discount period to last 10 days: Consumers using less than 5,000 cubic feet per *quarter*, 10 per cent. off; 5,000 to 10,000 per quarter, 15 per cent.; 10,000 to 20,000, 20 per cent.; 15,000 to 20,000, 25 per cent.; over 20,000, special agreement. No change will be made in the rate on gas used for fuel, which rules at the very liberal figure to the user of $1 per 1,000. Messrs. Atwater, Young and Tracy are a great trio when it comes to arbitration.

The Louisville (Ky.) Gas Saving Company has been incorporated by Messrs. Irwin, Dugan and James Buchanan.

Dr. N. Wiley Thomas, of Girard College, Phila., recently testified before the special committee of Philadelphia City Councils, charged with inquiring into the supply and distribution of gas in that city, that the Philadelphia Gas Improvement Company is supplying a gas that is fully up to the requirements of the contract under which it is working. He puts the candle value of the gas at 22, and avers that the gas is a thoroughly fixed gas. These opinions are based on a number of tests made by him at the works and at several points at various distances therefrom.

The Board of Gas and Electric Light Commissioners has presented its findings in the matter of the order passed by the Massachusetts Legislature instructing it to investigate the causes of the deaths in Boston from the inhalation of illuminating gas, and to report upon the best means for remedying the seeming dangers to which those who used gas containing a large percentage of carbonic oxide were exposed, etc. The Commission was divided in opinion, President Barker and Commissioner Gifford joining in one presentation, while Commissioner Schaff submitted a minority report. The majority report (which is introduced by a table giving the gas sales in Boston) goes on to say: "The quantity

given in the sales of the Bay State Company is the amount sold to private consumers. Nearly all of the gas made by this Company was sold to the Boston, Dorchester, Roxbury and South Boston Companies, and the total sales for all purposes were 1,084,312,100 feet. * * * The mixed gas sold by the Boston Companies contained about 84 per cent. of carbureted water gas and 16 per cent. of coal gas, and was made between January 1st and June 5th. Of the 23 fatalities given in the table, as occurring from the Boston Company's gas, 14 were in Wards 6, 7 and 8. Of these, 3 happened before and 11 after June 5. Of the non-fatal accidents in the same district, from the gas of this Company, 3 happened before and 5 after that date. As we understand the inquiries they relate to the comparative feasibility of supplying a certain district in the city of Boston with coal gas exclusively and supplying the entire city with a mixed coal and water gas, containing not more than 16 per cent. of carbonic oxide, etc. It should be observed at the outset that this inquiry involves the consideration of a somewhat difficult and complex problem in gas engineering. If we divide the fatalities during the year 1896, according to the sections of the city in which they occurred, we shall find that about 51 per cent. were located in Wards 6, 7 and 8 of Boston, and that the others were distributed generally over the remaining parts of Boston in which the gas made by the Boston, Bay State and Brookline Companies was sold. This district seems to correspond as closely as any to that described in the order as 'where tenement houses and lodging houses are most numerous.' It happens also that within this district are the old works of the Boston Gas Light Company, known as the North End Station, now equipped for the manufacture of both coal and water gas. So far, then, as the distributing system is concerned, there would seem to be serious difficulty in the plan proposed in this order for supplying this district with coal gas. If this district is to be supplied from existing coal and water gas plants, the gas must be made at either the North End or Commercial Point Stations. The North End Station has a manufacturing capacity of 1,300,000 feet of coal gas per diem. The maximum consumption in the area named would probably be about 1,500,000 feet. If the supply were to come from this station it would therefore be necessary to increase the capacity of this plant by the erection of additional benches and retort houses with a capacity of 200,000 cubic feet a day. It would also be necessary to erect two holders with a capacity of about 1,000,000 feet each, and to purchase land for the purpose, which would probably call for an expenditure of from $700,000 to $900,000." The report also shows how increased facilities would be necessary too at the Commercial Point works, and then goes on to say:

"The cost of the necessary work for this purpose would probably not exceed $450,000 or $500,000. If this expenditure were made and the plan inquired of carried out, we should then have two sections of the city separated only by a single street, or at most a single block, one supplied with gas of about 24 or 25 candle power, and the other portion supplied with about 18 candle power, with no reasonable expectation of a reduction in price on that account. From this point of view, the feasibility of the plan may well be doubted. There can be no reasonable doubt, however, that if such gas were distributed in this area the number of fatalities there occurring would be greatly reduced. The other proposition which we are asked to consider is the feasibility of supplying a mixed gas, with not more than 15 or 16 per cent. of carbonic oxide. This requirement calls for a mixture containing about 40 per cent. of water gas and 60 per cent. of coal gas. As the maximum daily output of the Bay State and Boston Companies has already exceeded 8,000,000 feet, it would be necessary to have a coal gas plant of at least 5,000,000 feet capacity, or an increase of about 2,000,000 feet per day. The nominal capacity of the coal gas works of the Dorchester, Roxbury and South Boston Companies is 1,225,000 feet, but the works at Dorchester have been unused since July, 1889; those at Roxbury since May, 1890; and those at South Boston since May, 1894. None of these works are now large enough to supply their districts; all combined would be unable to supply the amount needed; they would probably require extensive repairs to fit them for economical operation, and their distances from each other, and from the water gas plants, are so great that it would probably be more economical to erect an entirely new works at a single point than to undertake to repair and operate the three plants named. It would probably be advisable to enlarge the plant at Commercial Point to make the additional quantity necessary for the plans suggested. Coal gas could then be made at this station and water gas at the Bay State works, and the product of the two taken by large mains to some convenient third point, where they could be properly mixed and made ready for distribution. At the point of meeting of the gases it would be necessary to construct a number of large holders, which either alone or in combination with other holders would contain an entire day's output, or about 8,000,000 feet. The main already built from the Bay State works might be used under this arrangement, but it would probably be necessary to build a new main from the Commercial Point works, a distance of from 1 to 3 miles, according to the location of the mixing station. This construction would probably cost from $800,000 to $1,000,000, increasing by this amount the capital of the Bay State and Boston companies. This expenditure makes provision for the present consumption of the group of Boston and Bay State Companies, and does not include the Brookline. This Company has an extensive system of mains in Boston proper and the Roxbury and Brighton districts; also to some extent in Dorchester and South Boston. It makes water gas at its Allston station and has no coal gas plant. It has a capacity of about 4,000,000 feet and a maximum output of a little more than 3,000,000 feet. To supply a mixed gas with not more than 16 per cent. of carbonic oxide would require the construction of a complete coal gas plant, with a capacity of about 2,000,000 feet. A reliable answer to the question of whether the substitution of a mixed gas containing not over 16 per cent. of carbonic oxide would largely reduce the number of fatalities must depend in great measure upon data which the Board does not possess, and has been unable to obtain. As between 26 and 6 or 8 per cent. there seems to be a consensus of scientific opinion that a change from the former to the latter would greatly diminish the number of fatalities. As to the effect of a change from 26 to 16 per cent. there is not the same agreement. Reasoning from the fact that there is less of the poisonous ingredients, it would be reasonable to expect that the gas would be less dangerous, and that it would cause fewer fatalities. But if on the other hand, the length of the time during which persons in these accidents are usually exposed to the effects of the gas is a sufficient time to produce death from gas with 16 per cent. of carbonic oxide, then such percentage could not be expected to greatly reduce the number of fatal cases. It might allow the resuscitation of those persons who, as sometimes happens, are alive when found after being subjected to gas with 26 per cent., but are not restored to consciousness. It is doubtful if the lower percentage named would result in any considerable diminution of the number of fatalities. Experience can only satisfactorily answer this inquiry. If existing coal gas plants of the Boston, Dorchester, Roxbury and South Boston Companies were operated at their fullest capacity, it would be necessary at the time of greatest consumption to make about 4,000,000 or 5,000,000 feet of water gas per day. If the plant of the Boston Company only were thus operated the amount of water gas necessary would be about 5,000,000 or 6,000,000 feet per day. This amount would, of course, vary and decrease with change of output and change of season."

The minority report submitted by Commissioner Schaff is as follows: "I do not share my colleagues' doubts that a reduction of the present amount of carbonic oxide, running from 26 and 27 per cent. down to 16 per cent., would make any considerable reduction in the death rate. I think it would make a very considerable reduction. The gravity of the issue raised by the investigation and under which the opinion of the Board is asked 'for information upon matters of fact and for an expression of opinion,' involving, as it does, reasonable safeguards for human life and the security of heavy investments in the property devoted to the manufacture of water gas, imposes upon the Board the duty of giving further than a perfunctory answer and calls upon it to outline, as well as it may, a remedial policy that, in its judgment, will tend to secure both life and property. For reasons already set forth it seems clearly inadvisable to compel the Companies to make at once a mixed gas containing not over 16 per cent of carbonic oxide. But it does seem wise to inaugurate such a policy as will set them on the road to reach that proportion, or one of more or less than that percentage which experience may show to be the limit of reasonable safety. To this end and for their own welfare, since their interest cannot lie in the increasing death rate, the Companies themselves should co-operate. Let them, therefore, begin by again putting their North End and Commercial Point coal gas works in full operation; it would effect a material reduction, from 25 to 30 per cent. in the present amount of carbonic oxide in the gas supplied through the territory where the mortality was greatest, and with every reduction there is reason to believe there should be a diminution in the death rate. When and how this policy should be inaugurated should be left to the discretion of the Board, but it should be made obligatory."

It is likely that Mr. Nelson Hoyt, of Philadelphia, will succeed the late Mr. Thomas Bourne as Superintendent of the Clarksville (Tenn.) Gas Light Company.

At the annual meeting of the Cohoes (N, Y.) Gas Light Company no change was made in the executive management. It was, we believe, determined by the officers to reduce the selling rate to $1.75 per 1,000, a concession of 25 cents.

The Directors of the Universal Gas Company, of Chicago, have entered into contracts for the laying of 20 miles of mains in South and Southwest Chicago. The Company also has the option from the contractors of taking on an additional 20 miles, at the figures agreed upon for the initial contract.

Mr. John E. Gilcreast, son of Capt. John Gilcreast, Superintendent of the Woburn (Mass.) Gas Light Company, has been appointed Treasurer of the Mercantile Loan and Trust Company, of Boston. Mr. Gilcreast, who was for some time in the office of the Woburn Gas Light Company, under Treasurer Monks, is only in his 26th year.

The Niagara Falls (N. Y.) Gas Light Company will double its carbonizing capacity. The contract for the new benches, which are to be fired under the regenerative plan, has been awarded to Mr. Adam Weber, of this city.

Igniting Gas in Incandescence Lamps.

The *Journal of Gas Lighting* reports the issuance of English patent letters to J. M. Canellopoulos and H. O. Kratz-Boussac, of Paris, France, for improved methods of igniting gas in incandescence lamps.

The invention relates to means for igniting gas (more especially) in incandescence gas lamps, comprising carbon and palladium, combined to form a body capable of absorbing or condensing gases, and of being thereby brought into a state of incandescence.

The patentees point out that various attempts have been made to effect the ignition of gas jets by the mere contact of the gas with a substance capable of condensing or occluding a sufficiently large amount thereof, and of thus acquiring such an increase of temperature as to effect ignition of the gas. For this purpose there have been employed platinum and other metals of the same group, either in the form of "sponge" or in the form of "black," with suitable supports. The use of the "sponge" is open to the disadvantage that it has to be heated as a preliminary to its use for causing ignition of the gas brought into contact with it; and by the use of the "black," though ignition is produced, the "black" undergoes change—being converted into such a state that it no longer possesses the property of absorbing or occluding gases to to the same extent as in the "black" condition. Consequently, after a number of ignitions, the substance no longer acts effectively.

The present invention has reference to an igniter capable of producing the two-fold effect of igniting illuminating gas without having to be itself preliminarily heated, as the "sponge" has to be, and without losing its catalytical properties as the "black" does. The means by which this result is attained are based, among others, on the possibility of obtaining a very considerable increase in the number of the pores in retort carbon, so as to convert it into a substance capable of effecting a considerable condensation of gases.

For this purpose, retort carbon is divided into small pieces each of the desired form and size—for example, that of a small pellet or drop, 2 to 3 millimeters in diameter. It is then washed in distilled water, with the object of freeing it from the grosser impurities, after which it is dried. It is then heated to redness in a porcelain tube, through which a current of chlorine is simultaneously passed—say, for about 15 to 30 minutes, according to the quality of the carbon used. After this treatment, the carbon is cooled down to the ordinary temperature, and again washed and dried. The current of chlorine, by acting upon the various substances, and in particular upon metallic compounds which obstruct the pores in the carbon, produces a great multiplication of pores or cells of minute volume.

By this treatment the carbon will no longer be in its original condition, but will have acquired a capacity for absorbing gases. It is not, however, by itself capable of becoming incandescent, by absorption of gases therein. For the purpose of increasing its absorbing power, so that it can be used for the ignition of illuminating gas, it is impregnated with one or other of the following preparations or solutions of palladium: (1) Palladium is combined with chlorine to produce palladium chloride, which is dissolved in water, the quantity of which may be variable. (2) Palladium is dissolved in highly concentrated nitro-muriatic acid (*aqua regia*), whereby palladic chloride ($PdCl_4$) is formed.

The carbon pellets are immersed in one or other of the solutions mentioned, and then dried; the operation being repeated until the carbon has absorbed a sufficient quantity of palladium. It is finally allowed to dry at a temperature below 80° C.; and the pellets thus treated are then subjected to the action of a current of hydrogen, taking care to raise the temperature sufficiently high (say, about 170° C.) to compel the hydrogen to combine with the chlorine, and to penetrate into the pores of the carbon, so as to convert the palladium chloride into metallic palladium in a state of very fine subdivision.

In order to facilitate the ignition of the gas, the carbon pellet (prepared as described) is placed upon a small block of refractory material—steatite, clay, amianthus or other suitable material that is a bad conductor of heat—so that the pellet will retain practically the whole of the heat produced therein at the instant of absorption and condensation of the gas brought in contact with it.

Through the center of the carbon pellet are passed platinum or palladium wires or an alloy of platinum and iridium (say) in the proportion of 90 per cent. of platinum to 10 per cent. of iridium. The wires are bent into a loop to facilitate the ignition of the gas; the complete device—consisting of the carbon pellet, the refractory non-conducting block, and the wires—being mounted on the burner in such a manner that the issuing gas will come in contact with it.

Coal Formation in Iowa.

The report of the Iowa State geological corps gives some interesting data on coal mining in that State. It is said that the lower coal measures completely underlie Boone county. The Des Moines river has cut into this formation a channel averaging 100 feet in depth, and revealing a series of sandstones and shales with several veins of coal, which are interbedded in a most intricate manner. It is probable the coal measures may reach a thickness of nearly 300 feet at a certain point. Lithologically, the coal measure strata consist essentially of sandstone and shales, which contain several seams of coal of greater or less extent. The coal is entirely bituminous, and has upwards of 80 per cent. of oxidizable elements, chief among these being carbon. Boone county has long been one of the leading coal producing counties in the State. For nearly half a century it has been known to exist in the region in quantities of economic importance, and has long been mined to supply local wants. In the Madrid district the seam averages about 26 inches in thickness, is of fair quality, has a good roof, and is readily mined by drifting into the bank. With respect to the chemical analyses of Boone county coals, the author remarks that chemically a coal is usually considered desirable if it contains high percentages of fixed carbon and of hydrocarbons, and low percentages of water, ash and sulphur. He then gives the following analyses:

	1. Angus Mine. Average.	1a. Dalby Mine. Average.	2. Boonesboro. Average.	3. Fraser.
H_2O	8.62	2.84	12.37	14.77
Total comb	82.75	88.36	81.90	73.71
Ash.....	8.64	8.12	5.87	11.48
Vol. comb.	38.33	43.08	48.24	37.67
F. carb ...	44.41	45.29	43.72	36.05
Coke.....	53.05	54.08	49.41	47.53
Sulph	2.59	4.33	....	2.76
Sulphate..	0.08	0.14	....	0.19

He then goes on to say: To say that the entire region under consideration is underlain by the coal measures does not predicate that coal in workable amounts is universally distributed throughout Boone county. Sufficient data are not at hand to delimit the known coal basins, but certain it is that they have a much wider range than is suspected at the present time, Systematic prospecting has been confined almost wholly to the Des Moines Valley in the north central portion of the county, although they have been explored over very limited areas in the vicinity of Angus and Zenorsville. Fully 15 16 of the area of the county remains unexplored, and offers an attractive field for the prospector. The diamond core drill would be found a valuable adjunct to the equipment of the progressive operator, and a judicious use of this instrument in the further development of the coal mining industry in Boone county would, undoubtedly, be rewarded with adequate returns.

In Warren county the stumps and trunks of trees are not found extending through the coal, but rather an accumulation of leaves, twigs, and a broken carbonaceous mass is seen, with here and there—more usually in the shale—large branches, all of the usual type of vegetation belonging to the coal period. Remains of ferns and lepidodendrons are especially abundant. The upper seams of the upper group in this

(*Continued on page* 531.)

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county mark, it appears, quite an important coal horizon, and the coal under favorable conditions is quite uniformly 18 to 30 inches thick. Most of the mines are farmers' banks in the surface seams, most of which are worked in the winter only, requiring from one to five or six men. The output in 1895 was 12,000 tons.

Mr. H. Foster Bain, in writing the geology of Appanoosa county, says that this county lies within the coal field, and the beds are said to afford excellent illustration of the fact that minor differences in faunas are due to local conditions of life, which conditions may be inferred from the character of the strata then laid down. While the whole of the county is legitimate ground for prospecting, a more restricted area is known to contain coal of the sort called "mystic," and this area is 298 square miles. The coal will average about 2½ feet in thickness for the entire area, and upon the basis of 1,200 long tons per acre for each foot of thickness, should yield 3,600 short tons per acre. About 2,240 tons per acre are, it appears, obtained in actual practice. Only 62 per cent. of the coal is hoisted, and it is worked on the room and pillar system. Only about 18,457 acres out of the possible 190,720 acres underlain by the mystic coal is at present leased or owned by mining companies, or is held as coal land. The remainder of the region is held as farm land, though of course a good deal of it is held by people who will eventually open it up for mining. A little less than 10 per cent. of the coal land of the county is now taken up. Coal land already prospected usually sells at $15 per acre. At 6½ cents the royalty amounts to from $125 to $150 per acre, with an average probably of $140, with ordinary room and pillar workings. The mystic coal is a non-caking, free-burning coal. It is fragile and will not stand rough handling or long exposure. An analysis for the Thistle mine shows water, 5.80; volatile combustible by difference, 37.71; fixed carbon, 53; ash, 3.49; sulphur unoxidized, 2.97; sulphur in sulphates, .05. The coal is in demand for domestic purposes over a wide territory. It has never been used for gas or coke except experimentally. The mining methods are regular long wall, room and pillar, and semi long wall. There has been a change in the prices, but at the old rate a yard of entry work in summer costs about $3.40, and in winter $3.80. The machines in use are the Legg and the Harrison.

The Market for Gas Securities.

The market for city gas shares was largely of the professional order last week, real investors being somewhat timid over the general situation. As a consequence prices suffered, Consolidated selling down to 154½ on comparatively unimportant transactions. The hugger-muggering going on at Albany over the gas rate measures has attracted some attention during the week, and the action of the Senate yesterday (Thursday), in advancing the graded bill, while at the same time finally throttling the Cantor-Laimbeer dollar measure, as well as hanging up on the drying line Senator McNulty's municipal gas works purchase and operation scheme, shows that our predictions of a month or so ago were founded on more than mere likelihood. The situation in fact is all in favor of the Companies, and every city gas share is a purchase at the quoted prices. Equitable and Mutual are exceptionally strong, and we imagine that the latter will show a sharp advance shortly.

East River common keeps up with the procession in sturdy step, and its continued progress is merely a matter of time. The steady absorption of this stock by men prominently identified with local gas interests is uninterrupted. We quote it at 53¾ to 54¼. Standard issues are dull and strong. One of the amusing things of the week was the adoption, by the New York Aldermen, per Mister Noonan, of a resolution asking the Legislature to put the gas rate for New York city at $1 per 1,000.

The Brooklyn Union Company is billing its customers at $1.20 per 1,000, and allowing a rebate of 5 cents per 1,000 on all gas paid for since January 1st at the rate of $1.25 per 1,000. The rebate is being very generally accepted. The quotations for Brooklyn Union are lower than those of last week, but the figures are nominal rather than real. To-day (Friday) it opened at 96 to 98. We repeat our expression of belief that the shares would be nearer their normal value were they quoted 10 points higher. The bonds are steady. Chicago is fairly steady, and there is no doubt that a sharp advance would occur in these shares were the general financial situation less unsettled.

Bay State is neglected and lower, at 9½ to 10. The settlement of the gas affairs of Boston, from a financial point of view, seems to have resolved itself into a question of endurance merely. In this event we would prefer to "endure" with the people now in the ascendant; for the lapse of time can only result in the constant strengthening of their position. The Indiana stocks are in demand. Western, of Milwaukee, is moving upwards steadily. This Company is gaining ground all the time. Baltimore Consolidated shows no change.

Gas Stocks.

Quotations by Cochran & Close, Brokers and Dealers in Gas Stocks.

35 WALL ST., NEW YORK CITY.

APRIL 5.

☞ All communications will receive particular attention.
☞ The following quotations are based on the par value of $100 per share.

N. Y. City Companies.	*Capital.*	*Par.*	*Bid.*	*Asked.*
Consolidated	$35,430,000	100	155⅛	156
Central	500,000	50	195	..
" Scrip	220,000	..	100	.
Equitable	4,000,000	100	207	210
Bonds, 6's	1,000,000	1,000	105	..
" 1st Con. 5's	2,300,000	1,000	114	.
Metropolitan Bonds	658,000	..	108	112
Mutual	3,500,000	100	235	242
" Bonds	1,500,000	1,000	100	102
Municipal Bonds	750,000	.	.	
Northern	150,000	50	85	
" Bonds.	150,000	1,000	..	98
New York and East River	5,000,000	100	53¾	54¼
Preferred	2,000,000	100	89½	90½
Bonds 1st 5's	3,500,000	1,000	106¾	107¼
" 1st Con. 5's	1,500,000	.	98	99
Richmond Co., S. I.	348,650	50	50	..
" Bonds.	100,000	1,000		
Standard	5,000,000	100	86	87½
Preferred	5,000,000	100	110½	..
Bonds, 1st Mortgage, 5's	1,500,000	1,000	111½	113½
Yonkers	299,650	50	130	
Out-of-Town Companies.				
Brooklyn Union	15,000,000	100	96	98
" " Bonds (5's)	15,000,000	1,000	110	..
Bay State	15,000,000	50	9½	10
" Income Bonds	2,000,000	1,000	..	35
Boston United Gas Co.—				
1s Series S. F. Trust	7,000,000	1,000	..	85
2d " " "	3,000,000	1,000	70	72
Buffalo Mutual	750,000	100	125	..
" Bonds	200,000	1,000	95	100
Central, San Francisco	2,000,000	..	95	..
Chicago Gas Co.	25,000,000	100	78⅛	78¼
Chicago Gas Lt. & Coke Co. Guaranteed Gold Bonds.	7,650,000	1,000	94	94¼
Columbus	1,000,000	..	68	70
1st Mortgage	1,085,000	..	..	96
Consumers, Jersey City	2,000,000	100	..	30
" Bonds	600,000	1,000	101	102½
Cincinnati G. & C. Co.	8,500,000	100	202	203
Consumers, Toronto	1,600,000	50	184½	187
Capital, Sacramento	500,000	50	..	35
Bonds (6's)	150,000	1,000	..	..
Consolidated, Baltimore	1,000,000	100	60	60½
Mortgage, 6's	3,600,000	..	107	107½
Chesapeake, 1st 6's	1,000,000	..	..	..
Equitable, 1st 6's	910,000	..	..	..
Consolidated, 1st 5's	1,490,000	..	..	..
Detroit	4,000,000	..	22	..
" Con. Bonds	4,312,000	..	73½	74
Equitable Gas & Fuel Co., Chicago, Bonds	2,000,000	1,000	..	101
Fort Wayne	2,000,000	..	81	88
" Bonds	2,000,000	..	92	93½
Hartford	750,000	25	..	145
Indianapolis	2,000,000	..	130	135
" Bonds, 6's	2,650,000	..	105½	107½
Jersey City	750,000	20	180	..
Lafayette Gas Co., Ind.	1,000,000	100	84	87
Bonds	1,000,000	1,000	92	95
Louisville	2,570,000	50	..	..
Laclede, St. Louis	7,500,000	100	23½	24½
Preferred	2,500,000	100	73	78
Bonds	9,084,400	1,000	95¼	95⅝
Little Falls, N. Y.	50,000	100	..	100
Bonds	25,000	..	..	100
Montreal, Canada	2,000,000	100	200	.
Newark, N. J., Gas Co.	1,000,000	..	93	98
Bonds, 6's	4,000,000	..	123	..
New Haven	1,000,000	25	225	..
Oakland, Cal.	2,000,000	..	53½	54
" Bonds	750,000	..	..	..
Peoples Gas Lt. & Coke Co., Chicago, 1st Mortgage	20,100,00	1,000	..	108
2d "	2,500,000	1,000	104	105
Peoples, Jersey City	500,000	50	..	175
Rochester Gas & Elec. Co.	2,150,000	50	..	..
Preferred	2,150,000	50	88	..
Consolidated 5's	2,000,000	..	87½	90
San Francisco, Cal.	10,000,000	100	97¾	98¼
St. Paul Gas Light Co.	1,500,000	100	67½	70
1st Mortgage, 6's	650,000	..	84	87
Extension, 6's	600,000	..	..	..
General Mortgage, 5's	2,400,000	.	88	90
Syracuse, N. Y.	500,000	25	..	..
Washington, D. C.	2,000,000	20	250	
Western, Milwaukee	4,000,000	100	64	67
Bonds, 5's	3,556,000	.	93½	95½
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DIVIDEND NOTICE.

OFFICE OF THE UNITED GAS IMPROVEMENT CO., DREXEL BUILDING, PHILA., March 25, 1897.

The Directors have this day declared a quarterly dividend of 2 per cent. ($1 per share), payable on April 15, 1897, to stockholders of record at the close of business March 31. Checks will be mailed.

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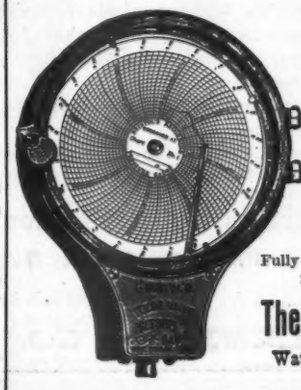

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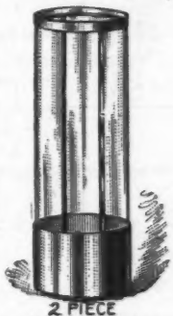

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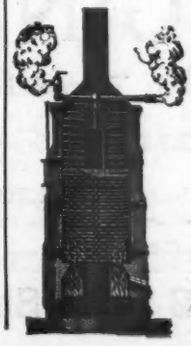

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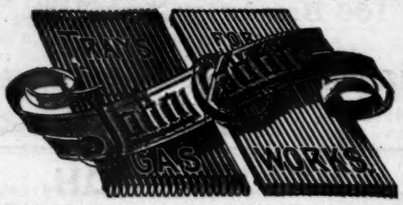

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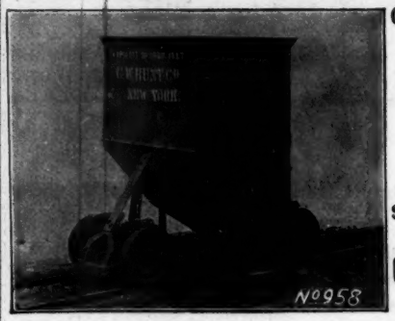

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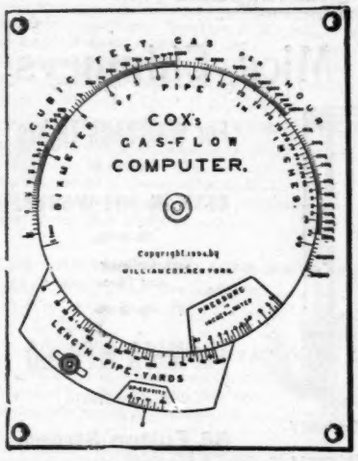

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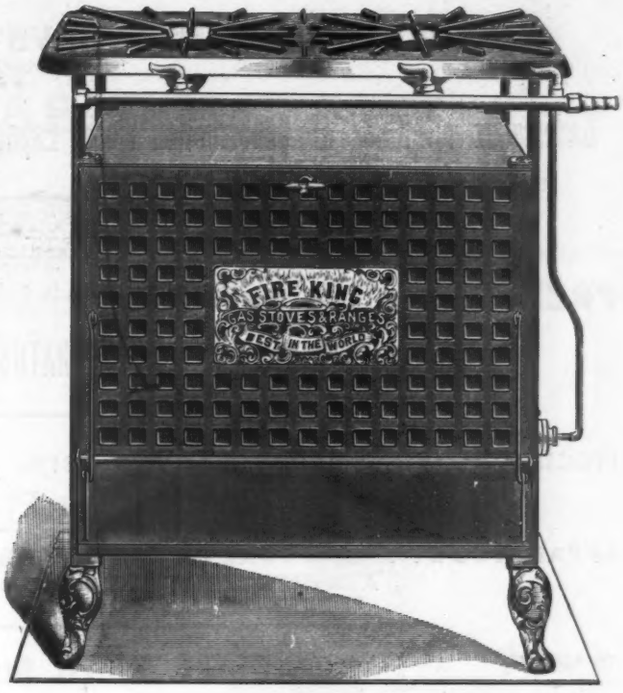

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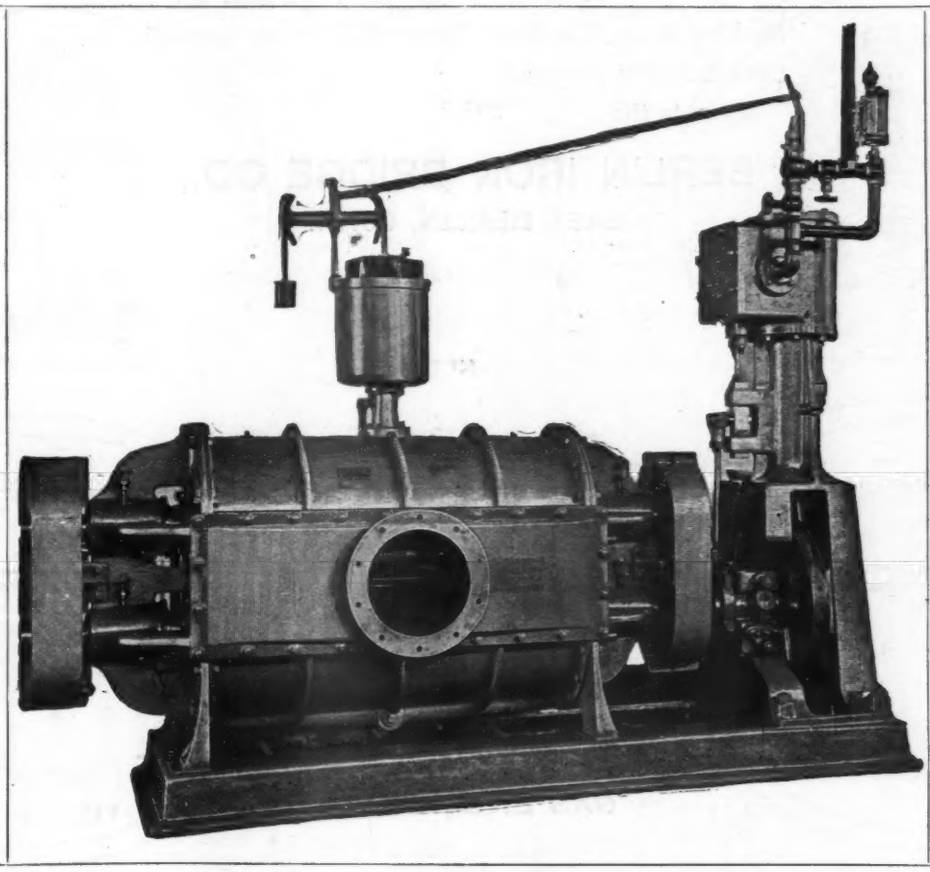

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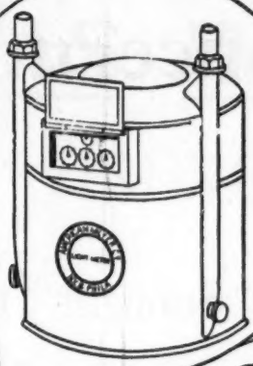
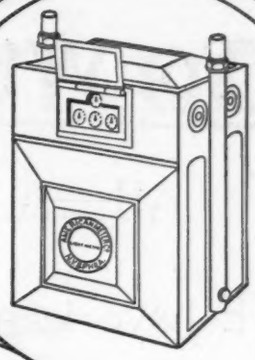
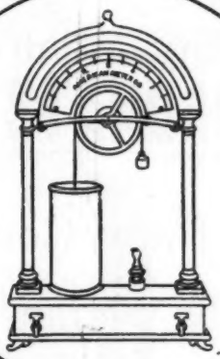


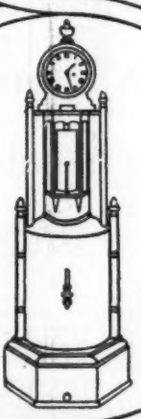


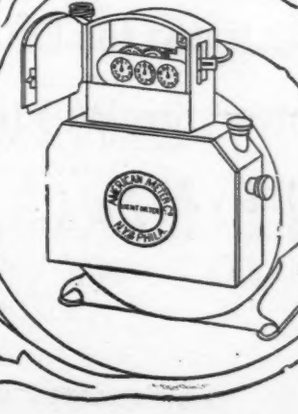


PUBLIC LIGHTING TABLE.

APRIL, 1897.

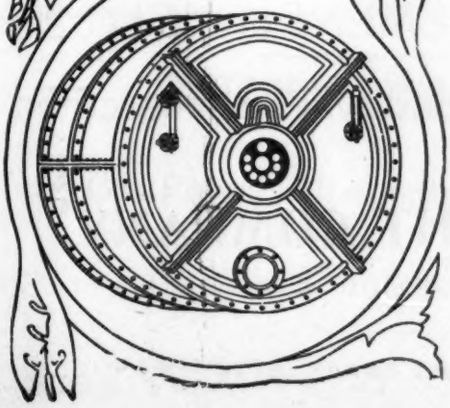
Day of Week.	Date.	Table No. 1. Following the Moon. Light.	Table No. 1. Following the Moon. Extinguish.	Table No. 2. New York City. All Night Lighting. Light.	Table No. 2. New York City. All Night Lighting. Extinguish.
				P.M.	A.M.
Thu.	1	6.50 PM NM	4.50 AM	6.10	4.55
Fri.	2	6.50	4.50	6.15	4.40
Sat.	3	6.50	4.50	6.15	4.40
Sun.	4	7.00	4.30	6.15	4.40
Mon.	5	7.00	4.30	6.15	4.40
Tue.	6	10.20	4.30	6.15	4.40
Wed.	7	11.10	4.30	6.15	4.40
Thu.	8	12.00 AM	4.30	6.15	4.40
Fri.	9	12.40 FQ	4.30	6.25	4.30
Sat.	10	1.20	4.30	6.25	4.30
Sun.	11	1.50	4.20	6.25	4.30
Mon.	12	2.10	4.20	6.25	4.30
Tue.	13	2.40	4.20	6.25	4.30
Wed.	14	3.10	4.20	6.25	4.30
Thu.	15	No L.	No L.	6.25	4.30
Fri.	16	No L. FM	No L.	6.30	4.20
Sat.	17	No L.	No L.	6.30	4.20
Sun.	18	7.20 PM	10.00 PM	6.30	4.20
Mon.	19	7.20	11.20	6.30	4.20
Tue.	20	7.20	12.30 AM	6.30	4.20
Wed.	21	7.20	1.20	6.30	4.20
Thu.	22	7.20	2.10	6.30	4.20
Fri.	23	7.20 LQ	2.40	6.40	4.10
Sat.	24	7.20	3.10	6.40	4.10
Sun.	25	7.20	3.30	6.40	4.10
Mon.	26	7.20	3.50	6.40	4.10
Tue.	27	7.20	4.00	6.40	4.10
Wed.	28	7.20	4.00	6.40	4.10
Thu.	29	7.20	4.00	6.40	4.10
Fri.	30	7.20	4.00	6.45	4.00





TOTAL HOURS LIGHTING DURING 1897.

By Table No. 1.	Hrs. Min.	By Table No. 2.	Hrs. Min.
January	233.00	January	423.20
February	187.20	February	355.25
March	202.00	March	355.35
April	170.40	April	298.50
May	163.00	May	264.50
June	140.40	June	234.25
July	151.40	July	243.45
August	167.30	August	280.25
September	174.40	September	321.15
October	200.00	October	374.30
November	205.20	November	401.40
December	220.10	December	433.45
Total, yr.	2216.00	Total, yr.	3987.45



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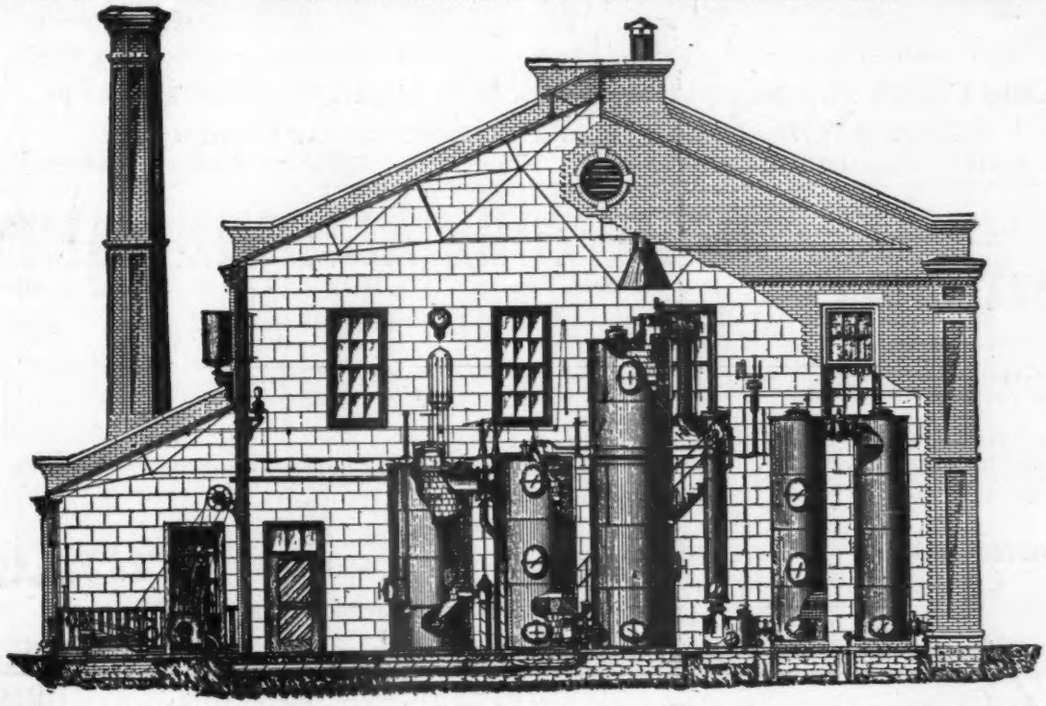

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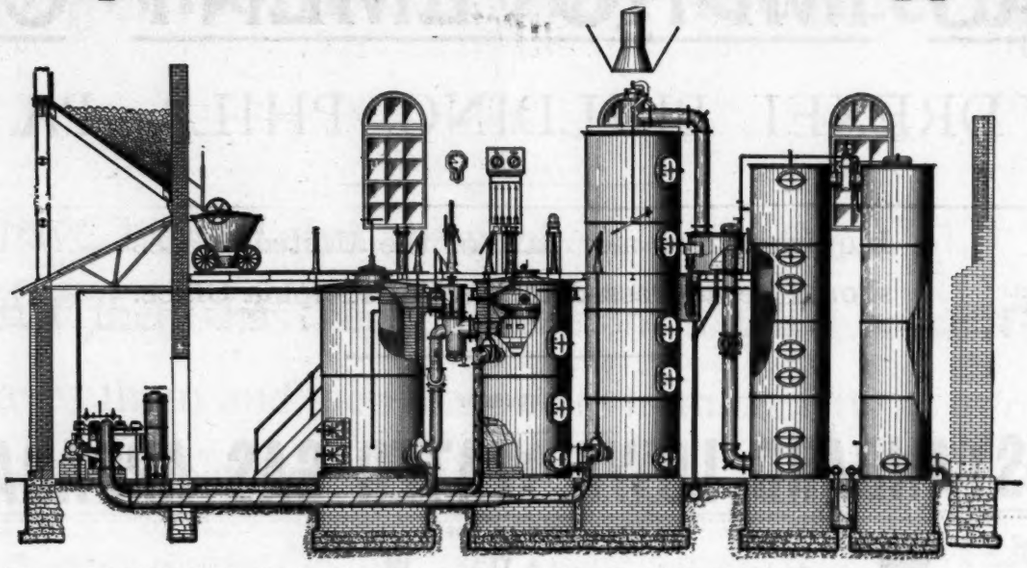

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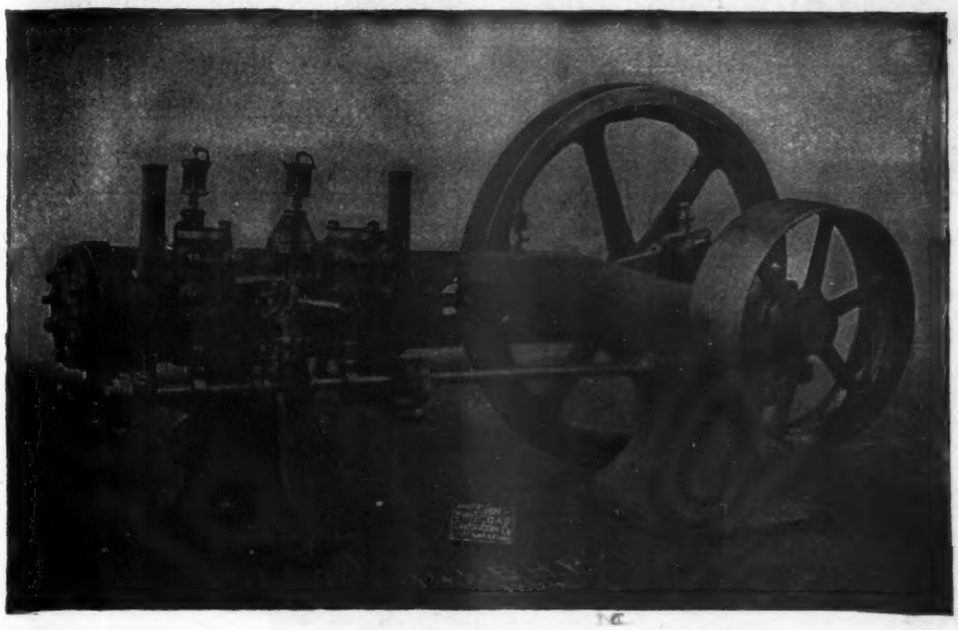

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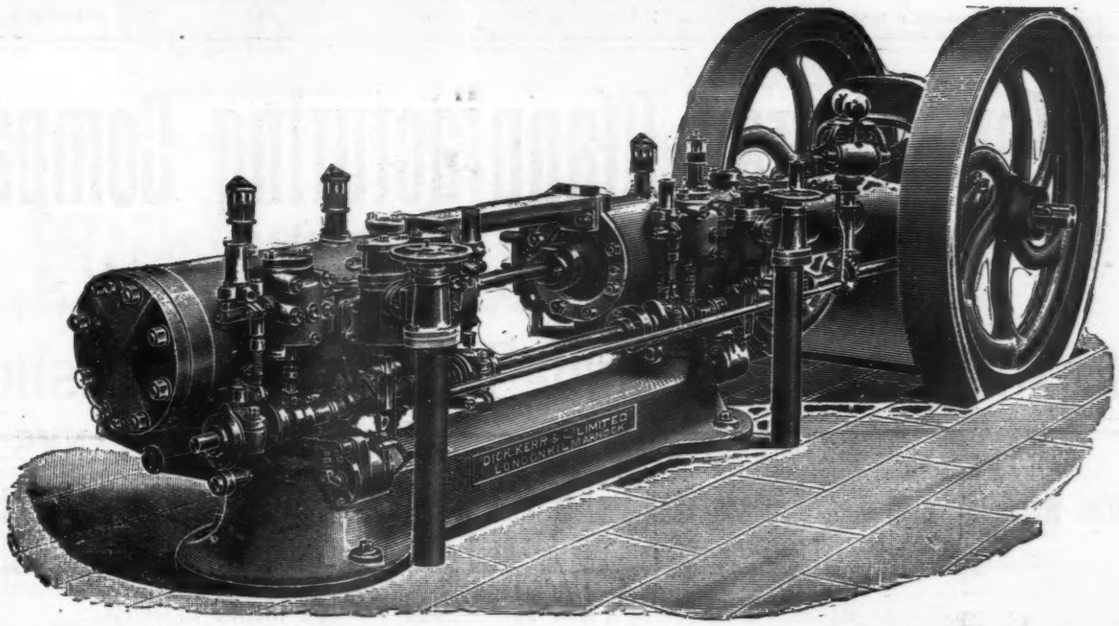

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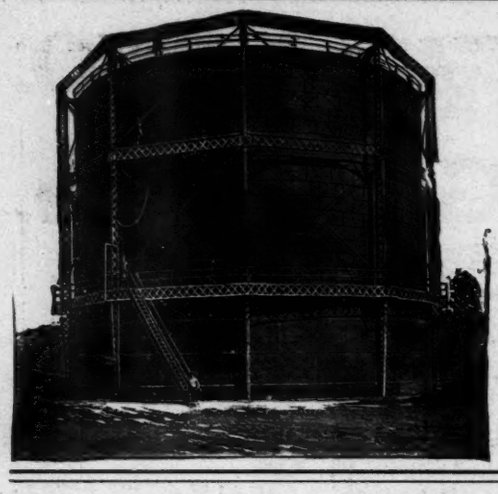

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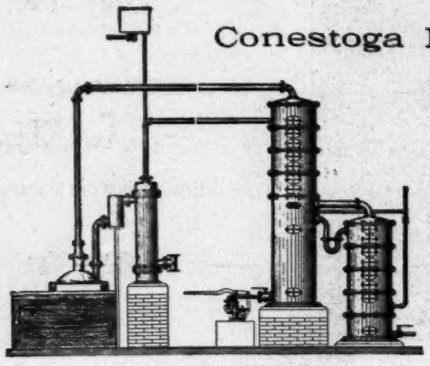

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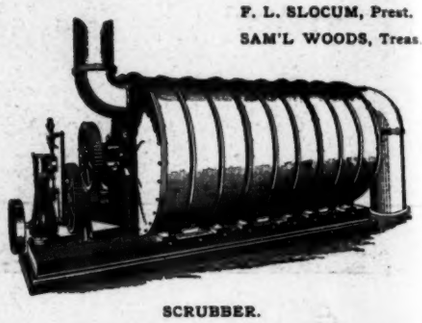

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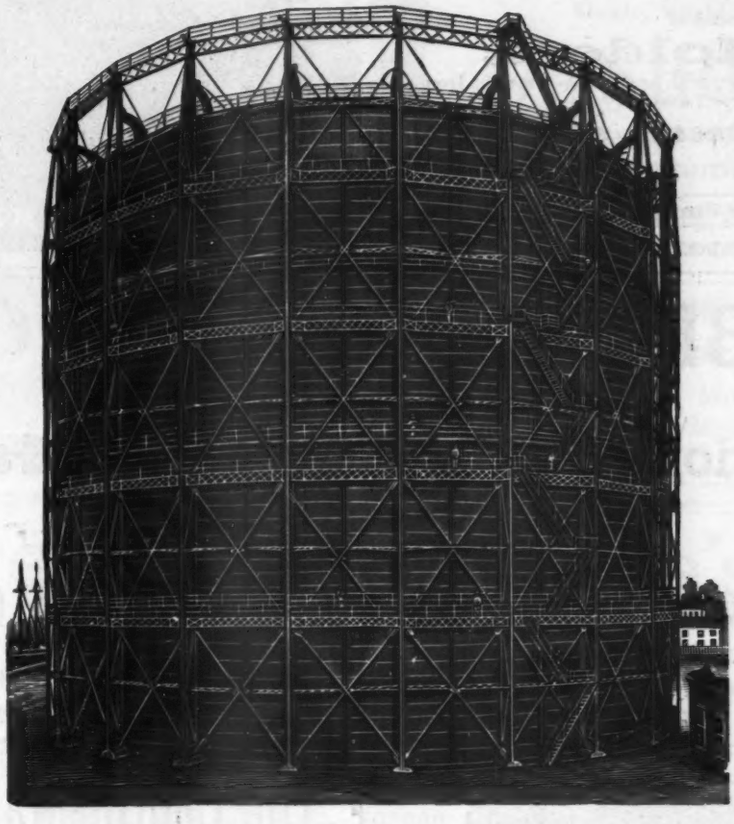

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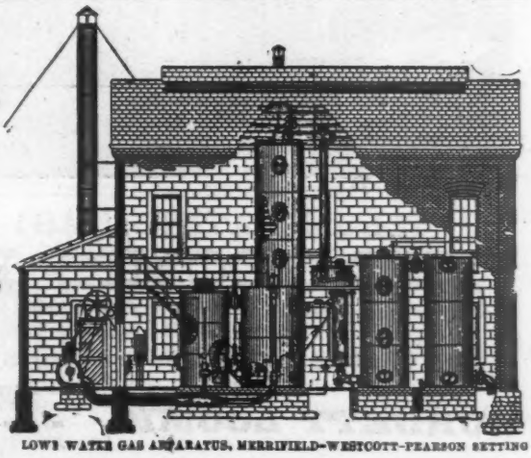

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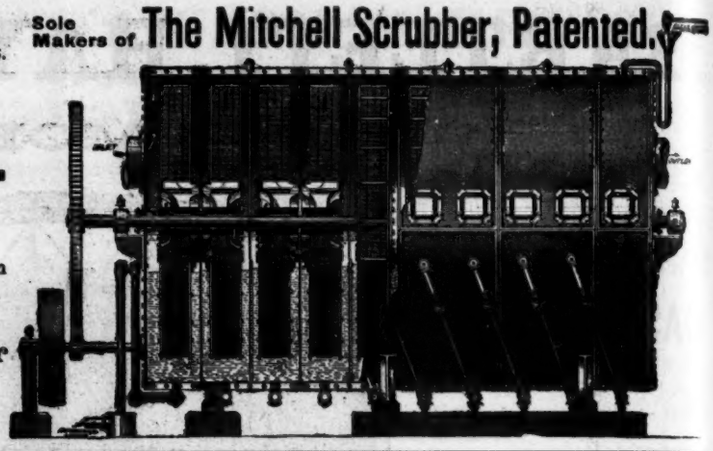

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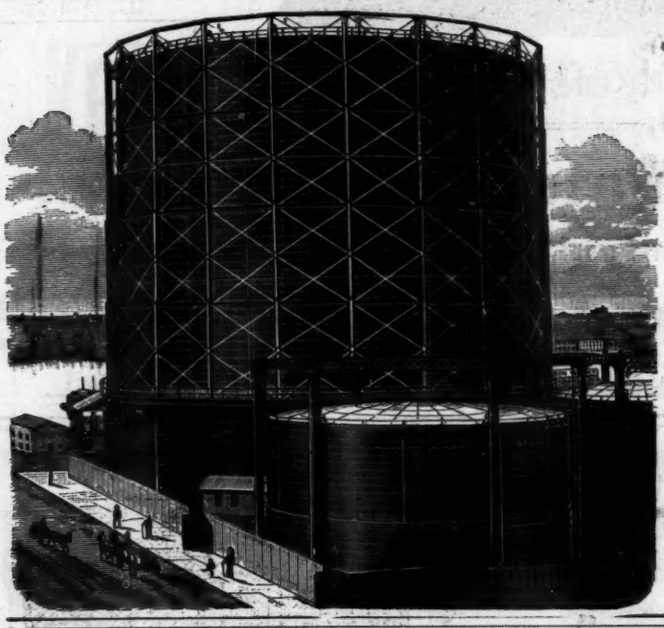

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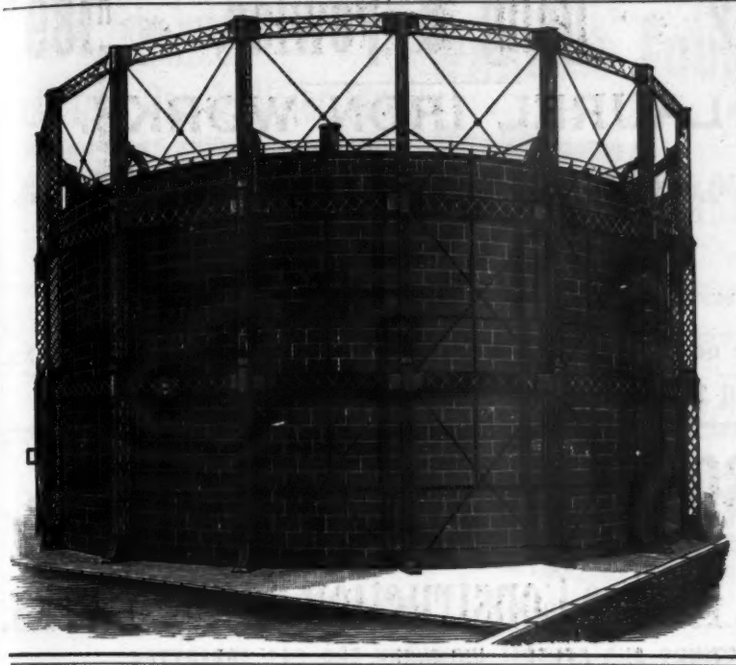

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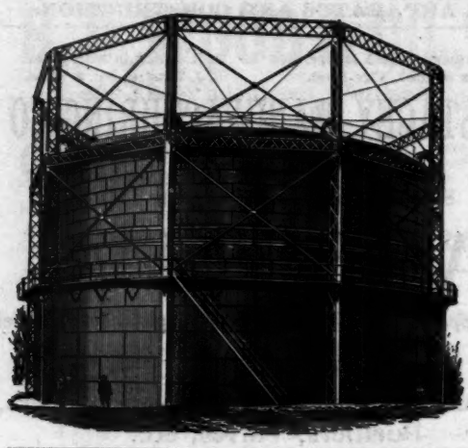

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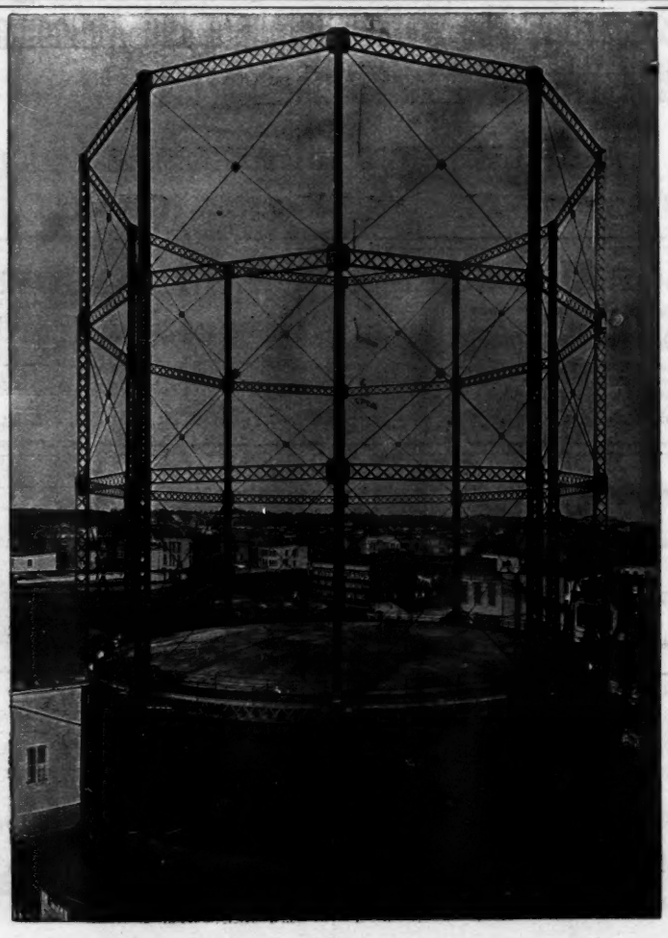

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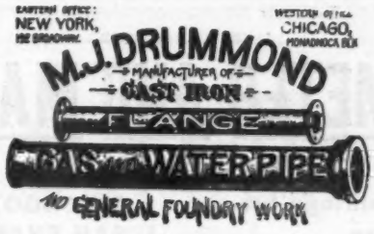

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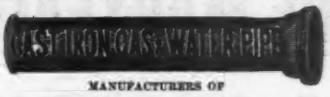

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Prompt Attention Given to All Repairing.

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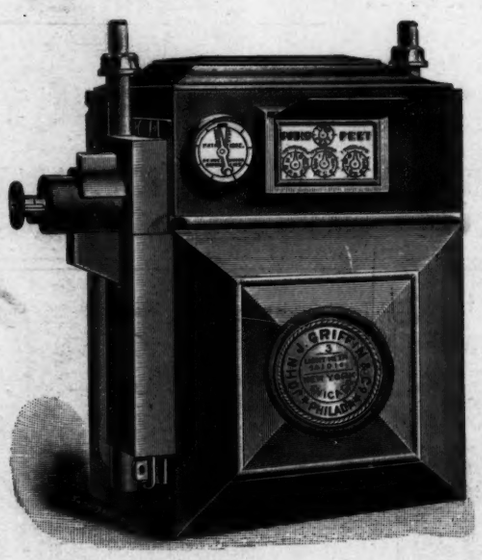

This Meter is an unqualified success in Great Britain. Its simplicity of construction, and the positive character of the service performed by it, have given it pre-eminence.

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